Fine aggregate shall conform to ASTM D 1073. Sand equivalent value shall be not less than 30.

2.1.2 Mineral Filler

Mineral filler for bituminous paving mixtures shall conform to ASTM D 242.

2.2 ASPHALT CEMENT

Cement shall conform to Section 916-1 of the FDOT Standards Specifications.

2.3 BITUMINOUS PRIME COAT

Bituminous prime coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.4 BITUMINOUS TACK COAT

Bituminous tack coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.5 JOB-MIX FORMULAS

A job-mix formula for each bituminous-concrete mixture proposed for use in the work shall be submitted for approval prior to start of work.

Job-mix formula shall be in accordance with FDOT Standard Specification Section 334.

2.6 PERFORMANCE REQUIREMENTS

Bituminous concrete mixtures shall meet the performance requirements of FDOT Standard Specification Section 334 for Type SP-9.5 Superpave Asphalt Concrete when sampled and tested, except the Contractor is to meet FDOT's requirements for a 1.00 pay factor. Sampling, test methods, and frequency shall be in conformance with FDOT Standard Specification Section 334.

2.7 PRECAST CAR STOPS

Provide car stops to the profile and size indicated. Manufacture with air entrained concrete having a minimum compressive strength of 3,000 psi at 28 days, with two No. 4 reinforcing rods located at mid-point of its cross section and with two galvanized sleeves for anchoring.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Excavation and Filling

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 EARTHWORK.

3.2 SUBBASE OR BASE COURSE

3.2.1 Preparation of Subgrade or Subbase

Prior to constructing the subbase or base course, the previously constructed subgrade or subbase course shall be cleaned of foreign substances. At the time of construction of the base course, the subgrade or subbase course shall contain no frozen material.

Ruts or soft, yielding spots that may appear in the subgrade or subbase course, areas having inadequate compaction and deviations of the surface from the requirements in the applicable section shall be corrected. Correction shall be performed by loosening the affected areas, removing unsatisfactory material, adding approved material and reshaping and recompacting to line and grade to the specified density requirements.

3.2.2 Placing and Compacting

Material shall be leveled to a uniform thickness so that the layer, after compaction, will not exceed 6 inches. Water shall be added by sprinkling and mixing or reduced by aeration as necessary. Mixing and aeration shall be accomplished until the water content is at optimum. Layer shall be compacted through the full depth to the specified density. In places inaccessible to rolling equipment, compaction shall be with approved mechanical compactors. Successive layers shall be constructed in a similar manner, scarifying between layers to ensure adequate bonding. Materials found unsatisfactory shall be replaced with satisfactory material or reworked to produce an acceptable standard.

3.2.3 Smoothness

Surface of each layer shall show no deviations in excess of 1/2 inch when tested with a 10-foot straightedge applied parallel with, and at right angles to, centerline of area to be paved.

3.2.4 Thickness Control

Completed thickness of the subbase or base course shall be within 1/2 inch of plan. Thicknesses shall be measured at intervals providing at least one depth measurement for each 500 square yards. Depth measurement shall be made by test holes 3 inches minimum in diameter. Where the measured thickness is more than 1/2-inch deficient, the areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting. Average job thickness shall be the average of job measurements within 1/4 inch of plan.

3.3 ASPHALT CONCRETE SURFACE COURSE

3.3.1 Weather Limitations

Weather limitations are stated in FDOT Standard Specifications Section 330 and as modified herein.

Bituminous prime and tack coats shall be applied only when the ambient temperature in the shade is above 50 degrees F or when the temperature has not been below 35 degrees F for 12 hours immediately prior to application. Application may commence when the aggregate base course is dry or contains moisture not in excess of the amount that will permit uniform distribution and the required penetration.

Bituminous-concrete courses shall be constructed only when the ambient temperature is above 40 degrees F and the underlying base course is dry.

3.3.2 Transportation of Mixtures

Bituminous-concrete mixtures shall be transported from the mixing plant to the project site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of a concentrated solution of hydrated lime and water to prevent adhesion of the mixture to the truck beds.

Each load of mixture shall be covered with canvas or similar material of sufficient size and weight to retard heat loss and to protect the mixture from the weather.

In cool weather or for long hauls, the entire contact area of each truck bed shall be insulated. Covers shall be securely fastened.

Deliveries of the mixture shall be so scheduled that the placing and compaction can be completed during daylight unless satisfactory artificial light is provided.

Mixture shall be delivered in a such manner that the temperature of the mixture at the time of dumping into the paver will be not less than 230 degrees F.

Trucks shall not travel on the mixture until compaction is complete and the bituminous-concrete pavement surface will support traffic without measurable deformation.

3.4 PREPARATION OF AREA TO BE PAVED

3.4.1 Surface Preparation

Preparation shall be in accordance with Section 300 of the FDOT Standard Specifications.

3.4.2 Priming the Base Course Surface

Priming the base course surface shall be in accordance with Section 300 of the FDOT Standard Specifications.

3.4.3 Priming Other Contact Surfaces

Contact surfaces of curbs, gutters, manholes, and other structures projecting into or abutting the concrete pavement shall be coated with a thin, uniform coating of bituminous tack-coat material prior to the bituminous-concrete mixture being placed against such structures.

Application shall conform to FDOT Standard Specifications Section 300-1.

Excess tack-coat material shall be squeegeed from the surface.

3.5 PLACING BITUMINOUS-CONCRETE COURSES

Placement shall be in accordance with FDOT Standard Specification Section 330 and Section 334, except at modified herein.

3.5.1 General

Bituminous-concrete mixture shall be placed on the prepared surface, uniformly spread and struck off. Bituminous-concrete courses shall be placed in layers of approximately equal thickness except that no layer shall be more than 2-inches thick after compaction. Courses shall be so placed that, when compacted, they will conform to the indicated grade, cross-section, and thickness.

3.5.2 Pavement Placing

Each paver shall be adjusted and the speed regulated so that the surface of the bituminous-concrete mixture will be smooth and, when compacted, will conform to the depths, cross sections, grades, and contours indicated.

Placing shall begin along the centerline of areas to be paved on a crowned section, at the high side of a section with a one-way slope and in the direction of the traffic flow. The mixture for each course shall be placed in strips not less than 10-feet wide. Progressive strip placement shall commence after rolling of the first strip. Rolling shall be extended to overlap the preceding strips. Placing the bituminous-concrete mixture shall be continuous.

Experienced shovelers and rakers shall follow each paver, adding hot bituminous-concrete mixture and raking the mixture as required to produce a course that, when completed, will conform to requirements specified.

3.5.3 Hand Placing

In areas where the use of machine spreading is not practicable, the mixture shall be spread and finished by the use of heated hand tools.

Mixture shall be dumped on approved dump boards and distributed into place from the dump boards in a uniformly loose layer of a thickness that will, when compacted, conform to required grade and thickness. Mixture shall be dumped no faster than it can be handled properly by the shovelers and rakers.

3.5.4 Joints

Joints shall have the same texture, density, and smoothness as other sections of the course. Joints between old and new pavements, or between successive days' work, shall be made to ensure a continuous bond between the old and new sections of the pavement.

Transverse joints in succeeding courses shall be offset at least 24 inches. The edge of the previously placed course shall be cut back to expose an even vertical surface over the full thickness of the course.

Longitudinal joints in succeeding courses shall be offset at least 6 inches. When the edges of longitudinal joints are irregular or do not conform to the specifications, the edge shall be cut back to expose an even vertical surface over the full thickness of the course.

3.6 COMPACTION

3.6.1 General

Compaction shall commence as soon after placing as the bituminous-concrete mixture will bear the weight of the roller without undue displacement.

Delays in compacting the freshly spread mixture will not be permitted.

During rolling, the wheels shall be kept moist with the minimum amount of water required to avoid picking up the bituminous-concrete mixture.

In places not accessible to the rollers, the mixture shall be compacted with hot hand tampers.

3.6.2 Rolling Procedure

Rolling shall commence longitudinally at the extreme sides of lanes and proceed toward the center of the pavement, except on superelevated curves. Rolling on superelevated curves shall commence on the low side and progress to the high side, overlapping on successive trips by at least one-half the width of the rear wheel of the roller.

Alternate trips of the roller shall be of slightly different lengths.

Rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. Speed of the rollers shall not exceed 3 miles per hour for steel-wheeled rollers or 5 miles per hour for pneumatic-tired rollers.

Rollers shall not be parked on the pavement.

3.6.3 Initial Rolling

The initial rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as possible without causing undue displacement.

Preliminary tests of crown, grade and smoothness shall be made immediately after the initial rolling.

Before the rolling is continued, deficiencies shall be corrected by adding or removing material so that the finished course will conform to the specified requirements for grade and smoothness.

3.6.4 Second Rolling

Second rolling shall follow the initial rolling as closely as possible, while the mixture is hot and in condition suitable for proper compaction.

Rolling shall be continuous (at least 3 complete coverages) after the initial rolling until the mixture has been compacted.

Causing undue displacement will not be permitted.

3.6.5 Finish Rolling

Finish rolling shall be done while the mixture is warm enough for the removal of roller marks. Rolling shall continue until all roller marks are eliminated and the course has the specified density.

3.6.6 Patching Deficient Areas

Bituminous-concrete mixtures that become mixed with foreign material or that are defective, such as low areas or "bird-baths," shall be removed, replaced with fresh bituminous-concrete mixture to obtain the required grade and smoothness for the finished surface, and compacted to the specified density.

Pavement in deficient areas shall be removed to the full thickness of the bituminous-concrete course and so cut that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Edges shall be sprayed with bituminous tack-coat material.

Skin patching an area that has been rolled will not be permitted.

3.6.7 Protection of Pavement

After final rolling, vehicular traffic shall not be permitted on the pavement until the pavement has cooled and hardened and in no case sooner than 6 hours.

3.7 ACCEPTANCE PROVISIONS

3.7.1 General

Density, surface smoothness, and thickness of completed bituminous-concrete base and surface courses shall be tested to verify compliance with the specified requirements.

3.7.2 Density and Thickness Requirements

Pavement specimens of each completed bituminous-concrete course shall be taken on the basis specified. Diameter of pavement core specimens shall be not less than 3 inches, and shall be through the entire base course and surface course. Locations for the removal of pavement specimens shall be directed by the Contract Officer. Test holes shall be repaired.

Perform testing in conformance with Section 334 of FDOT Standard Specifications.

Thickness shall not vary from the indicated thickness by more than 1/2 inch for the base course and 1/4 inch for the surface course.

3.7.3 Surface Requirements

Surface requirements shall be as provided in FDOT Standard Specifications Section 330-13, except as modified herein.

The finished surface of each bituminous-concrete course shall be tested for smoothness with a 10-foot straightedge applied parallel with, and at right angles to, the centerline of the paved area. The entire paved area shall be checked from one side to the other. Advancement along the pavement shall be in successive stages of not more than half the length of the straightedge.

Final surface shall have a uniform texture and shall conform to the required grade and cross section. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing them.

3.8 WASTE MANAGEMENT

Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

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AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

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SECTION 32 11 23

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2009) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2008a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E 11	(2009) Wire Cloth and Sieves for Testing Purposes

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 160	(2010) Stabilizing
Section 285	(2010) Optional Base Course

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Graded-Crushed Aggregate Base Course

Graded-crushed aggregate (GCA) base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction. GCA is similar to ABC, but it has more stringent requirements and it produces a base course with higher strength and stability.

1.2.3 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve are expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SYSTEM DESCRIPTION

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work.

SD-06 Test Reports

Sampling and Testing; G

Field Density Tests; G

1.5 QUALITY ASSURANCE

1.5.1 Tests

Provide waybills and delivery tickets, and perform sampling and testing in conformance with the applicable standards listed.

1.5.1.1 Sieve Analysis

Make sieve analysis in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

1.5.1.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D 4318.

1.5.1.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with AASHTO T 180, Method D and corrected with AASHTO T 224.

1.5.1.4 Field Density Tests

Measure field density in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938.

1.5.2 Testing Frequency

1.5.2.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

1.5.2.2 In Place Tests

Perform each of the following tests on samples taken from the placed and compacted ABC and GCA. Samples shall be taken and tested at the rates indicated. Perform sampling and testing of recycled concrete aggregate at twice the specified frequency until the material uniformity is established.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the total thickness of the base course at intervals, in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

As specified in FDOT Section 160 and Section 285 and all reference sections within. Allowable material shall be limited to limerock only.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

As specified in FDOT Section 160 and Section 285 and all referenced sections within.

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PAVEMENT MARKINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(2009) Standard Specification for Glass Beads Used in Pavement Markings

ASTM INTERNATIONAL (ASTM)

ASTM D 4280	(2008) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers
ASTM D 4505	(2005) Preformed Retroflective Pavement Marking Tape for Extended Service Life
ASTM D 792	(2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM E 28	(1999; R 2009) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325	(Rev D) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(Rev E) Paint, Traffic and Airfield Markings, Waterborne

1.2 SYSTEM DESCRIPTION

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Submit lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.2.1 Paint Application Equipment

1.2.1.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 5 mph, and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. Equipment used for marking streets and highways shall be capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.2.1.2 Hand-Operated, Push-Type Machines

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

1.2.2 Thermoplastic Application Equipment

1.2.2.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.2.2.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.2.2.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

a. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.020 to 0.190 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

(1) The mobile unit shall be equipped with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall be used. Heating of the composition by direct flame will not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle. The mobile unit shall be equipped with a minimum of two extrusion shoes located one on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. Each extrusion shoe shall be a closed, oil-jacketed unit; shall hold the molten thermoplastic at a temperature of 375 to 425 degrees F; and shall be capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.125 inch nor more than 0.190 inch, and of generally uniform cross section.

(2) The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

b. Portable Application Equipment: The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thicknesses of not less than 0.125 inch nor more than 0.190 inch and of generally uniform cross section.

1.2.3 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.2.4 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

1.2.5 Surface Preparation Equipment

1.2.5.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.2.5.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.2.6 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.2.6.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.2.6.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G
Composition Requirements; G
Qualifications; G

SD-06 Test Reports

Sampling and Testing; G

SD-07 Certificates

Volatile Organic Compound (VOC); G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

1.4.2 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.4.3 Maintenance of Traffic

1.4.3.1 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

1.5 DELIVERY, STORAGE, AND HANDLING

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.6 ENVIRONMENTAL REQUIREMENTS

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for roads, parking areas, and streets shall conform to FS TT-P-1952, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.2 THERMOPLASTIC COMPOUNDS

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.2.1 Composition Requirements

Submit Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use. The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

Component	Percent by Weight	
	White	Yellow
Binder	17 min.	17 min.
Titanium dioxide	10 min.	-

Component	Percent by Weight	
	White	Yellow
Glass beads	20 min.	20 min.
Calcium carbonate and inert fillers	49 max.	*
Yellow pigments	-	*
*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.		

2.2.2 Physical Properties

2.2.2.1 Color

The color shall be as indicated.

2.2.2.2 Drying Time

When installed at 70 degrees F and in thicknesses between 1/8 and 3/16 inch, after curing 15 minutes.

2.2.2.3 Softening Point

The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

2.2.2.4 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.2.3 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic compound (VOC). Submit certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

2.2.4 Portland Cement Concrete Primer

The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition. Epoxy primers recommended by the manufacturer shall be approved by the Contracting Officer prior to use. Requests for approval shall be accompanied with technical data, instructions for use, and a 1 quart sample of the primer material.

2.3 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

2.4 RAISED REFLECTIVE MARKERS

Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors, as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 4 inches, and shall be spaced not more than 40 feet apart on solid longitudinal lines. Markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D 4280.

2.5 REFLECTIVE MEDIA

Reflective media for roads and streets shall conform to FS TT-B-1325, Type I, Gradation A or AASHTO M 247, Type I.

2.6 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Submit certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers in the presence of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Thoroughly clean surfaces to be marked before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

3.1.1 Pretreatment for Early Painting

Where early painting is required on rigid pavements, apply a pretreatment with an aqueous solution, containing 3 percent phosphoric acid and 2 percent zinc chloride, to prepared pavement areas prior to painting.

3.1.2 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Remove existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.1.3 Cleaning Concrete Curing Compounds

On new portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.

b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.

c. All remaining curing compound is intact; all loose and flaking material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified . Provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

a. Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet/gallon. Glass spheres shall be applied uniformly to the wet paint on road and street pavement at a rate of 6 plus or minus 0.5 pounds of glass spheres per gallon of paint.

b. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet/gallon.

3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.2 Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint.

3.2.2.1 Longitudinal Markings

All centerline, skipline, edgeline, and other longitudinal type markings shall be applied with a mobile applicator. All special markings, crosswalks, stop bars, legends, arrows, and similar patterns shall be placed with a portable applicator, using the extrusion method.

3.2.2.2 Primer

After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the thermoplastic composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the thermoplastic manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

a. Asphalt Concrete Primer: Primer shall be applied to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch (265-400 square feet/gallon).

b. Portland Cement Concrete Primer: Primer shall be applied to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 0.04 to 0.05 inch (320-400 square feet/gallon).

3.2.2.3 Markings

After the primer has "set-up", the thermoplastic shall be applied at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, drop-on glass spheres shall be mechanically applied so that the spheres are held by and imbedded in the surface of the molten material.

a. Extruded Markings: All extruded thermoplastic markings shall be applied at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch.

b. Sprayed Markings: All sprayed thermoplastic markings shall be applied at the specified width and the thicknesses designated in the contract plans. If the plans do not specify a thickness, centerline markings shall be applied at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch plus or minus 0.005 inch.

c. Reflective Glass Spheres: Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 1 pound/20 square feet of compound.

3.2.3 Preformed Tape

The pavement surface temperature shall be a minimum of 60 degrees F and the ambient temperature shall be a minimum of 60 degrees F and rising. The preformed markings shall be placed in accordance with the manufacturer's written instructions.

3.2.4 Raised Reflective Markers

Prefabricated markers shall be aligned carefully at the required spacing and permanently fixed in place by means of epoxy resin adhesives. To insure good bond, pavement in areas where markers will be set shall be thoroughly cleaned by sandblasting and use of compressed air prior to applying adhesive.

3.2.5 Reflective Media

Application of reflective media shall immediately follow application of pigmented binder. Drop-on application of glass spheres shall be accomplished to insure that reflective media is evenly distributed at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, operations shall be discontinued immediately until deficiency is corrected.

3.3 MARKING REMOVAL

Pavement marking, including plastic tape, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Debris shall be disposed of at approved sites.

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CHAIN LINK FENCES

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SECTION 32 31 13

CHAIN LINK FENCES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A116	(2011) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A702	(1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A90/A90M	(2009) Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM B117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM C 94/C 94M	(2011) Standard Specification for Ready-Mixed Concrete
ASTM F 1043	(2011) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(2010) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F 567	(2011) Standard Practice for Installation of Chain Link Fence
ASTM F 626	(2008) Standard Specification for Fence Fittings
ASTM F 883	(2009) Padlocks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191	(Rev K) Fencing, Wire and Post Metal (and Gates, Chain-Link Fence Fabric, and Accessories)
FS RR-F-191/1	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)
FS RR-F-191/3	(Rev E; Am 1) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)
FS RR-F-191/4	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Assembly

Location of Corner, End, and Pull Posts

Erection/Installation Drawings

SD-03 Product Data

Fence Assembly

Zinc Coating

Fabric

Stretcher Bars

Concrete

SD-04 Samples

Fabric

Posts

Braces

Line Posts

Sleeves

Top Rail

Tension Wire

Stretcher Bars

Padlocks

Wire Ties

SD-07 Certificates

Certificates of Compliance

SD-08 Manufacturer's Instructions

Fence Assembly

Hardware Assembly

Accessories

1.3 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, hardware, and accessories.

Submit erection/installation drawings along with manufacturer's catalog data for complete fence assembly, hardware assembly and accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.5 QUALITY ASSURANCE

1.5.1 Required Report Data

Submit reports of listing of chain-link fencing and accessories regarding weight in ounces for zinc coating.

1.5.2 Certificates of Compliance

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

a. Zinc coating

b. Fabric

c. Stretcher bars

d. Concrete

PART 2 PRODUCTS

2.1 GENERAL

Provide fencing materials conforming to the requirements of ASTM A116, ASTM A702, ASTM F 626, and as specified.

2.2 ZINC COATING

Provide hot-dip galvanized (after fabrication) ferrous-metal components and accessories, except as otherwise specified.

Provide zinc coating of weight not less than 1.94 ounces per square foot, as determined from the average result of two specimens, when tested in accordance with ASTM A90/A90M.

Provide zinc coating conforming to the requirements of the following:

a. Pipe: FS RR-F-191/3 Class 1 Grade A in accordance with ASTM F 1083.

b. Hardware and accessories: ASTM A153/A153M, Table 1

c. Surface: ASTM F 1043

d. External: Type B-B surface zinc with organic coating, 0.97 ounce per square foot minimum thickness of acrylated polymer.

e. Internal: Surface zinc coating of 0.97 ounce per square foot minimum.

Provide galvanizing repair material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

2.3 FABRIC

FS RR-F-191 and detailed specifications as referenced and other requirements as specified.

FS RR-F-191/1; Type I, zinc-coated steel, 4 gage. Mesh size, 2 inches. Provide selvage knuckled at one selvage and twisted and barbed at the other. Height of fabric, as indicated.

Provide fabric consisting of No. 9-gage wires woven into a 2-inch diamond mesh, with dimensions of fabric and wire conforming to ASTM A116, ASTM A702 and ASTM F 626, with 1.29 ounces per square foot zinc galvanizing.

Provide one-piece fabric widths for fence heights up to 12 feet.

2.4 TOP AND BOTTOM SELVAGES

Provide knuckled selvages at top and bottom for fabric with 2 inch mesh and up to 60 inches high, and if over 60 inches high, provide twisted and barbed top selvage and knuckled bottom selvage.

Knuckle top and bottom selvages for 1-3/4-inch and 1-inch mesh fabric.

2.5 POSTS, TOP RAILS, BOTTOM RAILS, AND BRACES

FS RR-F-191/3 line posts; Class 1, steel pipe, Grade A. End, corner, and pull posts; Class 1, steel pipe, Grade A. Braces and rails; Class 1, steel pipe, Grade A. Steel pipe, Class 1, Grade B meeting the following performance criteria when subjected to salt spray testing in accordance with ASTM B117:

a. Exterior 1,000 hours with maximum 5 percent red rust.

b. Interior 650 hours with maximum 5 percent red rust.

2.6 LINE POSTS

Minimum acceptable line posts are as follows:

Up to 6-feet high:

Grade A: 1.900 inch O.D. pipe weighing 2.72 pounds per linear foot.

2.7 END, CORNER, AND PULL POSTS

Provide minimally acceptable end, corner, and pull posts as follows:

Up to 6 feet high:

Grade A: 2.375 inch O.D. pipe weighing 3.65 pounds per linear foot.

2.8 SLEEVES

Provide sleeves if needed for setting into concrete construction of the same material as post sections, sized 1-inch greater than the diameter or dimension of the post. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.9 TOP RAIL

Provide a minimum of 1.660 inches O.D. pipe rails. Grade A weighing 2.27 pounds per linear foot. Provide expansion couplings 6-inches long at each joint in top rails.

2.10 CENTER RAILS BETWEEN LINE POSTS

For fencing over 6-feet high, provide 1.660 inches O.D. pipe center rails, Grade A weighing 2.27 pounds per linear foot.

2.11 POST-BRACE ASSEMBLY

Provide bracing consisting of 1.660 inches O.D. pipe Grade A weighing 2.27 pounds per linear foot and 3/8 inch adjustable truss rods and turnbuckles.

2.12 TENSION WIRE

Provide galvanized wire, No. 7-gage, coiled spring wire, provided at the bottom of the fabric only. Provide zinc coating that weighs not less than 1.6 ounces per square foot.

2.13 STRETCHER BARS

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 3/16 by 3/4 inch, in accordance with ASTM A116, ASTM A702 and ASTM F 626.

2.14 POST TOPS

Provide tops that are steel, wrought iron, or malleable iron designed as a weathertight closure cap. Provide one cap for each post, unless equal protection is provided by a combination post-cap and barbed-wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

2.15 STRETCHER BAR BANDS

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

2.16 BARBED WIRE AND SUPPORT ARM

Barbed wire shall be 12 gauge steel wire, galvanized. Support arms shall be galvanized steel three-strand.

2.17 MISCELLANEOUS HARDWARE

Provide miscellaneous hot-dip galvanized hardware as required.

2.18 WIRE TIES

Provide 16-gage galvanized steel wire for tying fabric to line posts,spaced 12 inches on center. For tying fabric to rails and braces, space wire ties 24 inches on center. For tying fabric to tension wire, space 0.105-inch hog rings 24 inches on center.

Manufacturer's standard procedure will be accepted if of equal strength and durability.

FS RR-F-191/4. Provide wire ties constructed of the same material as the fencing fabric.

2.19 CONCRETE

Provide concrete conforming to ASTM C 94/C 94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.20 GROUT

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

2.21 PADLOCKS

Provide padlocks conforming to ASTM F 883, with chain.

PART 3 EXECUTION

Provide complete installation conforming to ASTM F 567.

3.1 GENERAL

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.2 EXCAVATION

Provide excavations for post footings which are drilled holes in virgin or compacted soil, of minimum sizes as indicated.

Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3-inches below the bottoms of the posts. Set bottom of each post not less than 36-inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Remove excavated soil from Government property.

When solid rock is encountered near the surface, drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull, and corner posts. Drill holes at least 1 inch greater in diameter than the largest dimension of the placed post.

If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

3.3 SETTING POSTS

Remove loose and foreign materials from holes and the soil moistened prior to placing concrete.

Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.

Maintain vertical alignment of posts set in concrete construction until concrete has set.

3.3.1 Earth and Bedrock

Provide concrete bases of dimensions indicated. Compact concrete to eliminate voids, and finish to a dome shape.

3.3.2 Concrete Slabs and Walls

Set posts into zinc-coated sleeves, set in concrete slab or wall, to a minimum depth of 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections into sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

3.3.3 Bracing

Brace corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

3.4 CONCRETE STRENGTH

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires until the concrete has attained its full design strength.

Take samples and test concrete to determine strength as specified.

3.5 TOP RAILS

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.6 CENTER RAILS

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

3.7 BRACE ASSEMBLY

Provide bracing assemblies at end posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension.

Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.8 TENSION WIRE INSTALLATION

Install tension wire by weaving them through the fabric and tying them to each post with not less than 7-gage galvanized wire or by securing the wire to the fabric with 10-gage ties or clips spaced 24 inches on center.

3.9 FABRIC INSTALLATION

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 1-1/2-inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed.

Ensure fabric remains under tension after the pulling force is released.

3.10 STRETCHER BAR INSTALLATION

Thread stretcher bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.11 TIE WIRES

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.12 FASTENERS

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.13 ZINC-COATING REPAIR

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.14 TOLERANCES

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing that is true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.15 SITE PREPARATION

3.15.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing. Establish a graded, compacted fence line prior to fencing installation.

3.16 FENCE INSTALLATION

Install fence on prepared surfaces to line and grade indicated. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.16.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feeton center. Do not exceed 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Provide drawings showing location of corner, end, and pull posts.

3.16.2 Top and Bottom Tension Wire

Install bottom tension wires before installing chain-link fabric, and pull wires taut. Place bottom tension wires within 8 inches of respective fabric line.

3.17 ACCESSORIES INSTALLATION

3.17.1 Post Caps

Install post caps as recommended by the manufacturer.

3.18 GROUNDING

Ground fencing as specified.

Ground fences at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations can not exceed 650 feet. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Provide ground conductor consisting of No. 8 AWG solid copper wire. Provide copper-clad steel rod grounding electrodes 3/4 inch by 10 foot long. Drive electrodes into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 12 inches deep and radially from the fence, with top of the electrode not less than 2 feet or more than 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Total resistance of the fence to ground cannot exceed 25 ohms.

3.19 CLEANUP

Remove waste fencing materials and other debris from the work site.

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SODDING

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SECTION 32 92 23

SODDING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 162	(2010) Prepared Soil Layer

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Not used.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Argentine Bahia sod shall be well matted with live grass roots. Sod shall be sufficiently thick to hold together during handling operations and to obtain a satisfactory growth of grass. Sod shall be live, fresh, and uninjured at the time of planting and it shall be the Contractor's responsibility to ensure that it contains sufficient moisture at planting to produce growth. Before the sod is harvested, the grass shall be mowed to the average height normally maintained for that variety of grass and shall have all clippings removed. Presence of weeds or other material which might be detrimental to the proposed planting will be cause for rejection of sod.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.2 TOPSOIL

Supply and install topsoil in accordance with FDOT Standard Section 162.

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.4 FERTILIZER

Provide commercial fertilizer of neutral character, with some elements derived from organic sources, containing not less than 8 percent phosphoric acid, 8 percent potassium, and percentage of nitrogen required to provide less than 1 pound of actual nitrogen per 1,000 square feet of area. Provide nitrogen in form that will be available to the seeded and sodded area during initial period of growth. The chemical designation shall be 5-10-10.

Ensure that the fertilizer is delivered to the site in labeled bags or containers.

2.5 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

Provide 4 inches of off-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.2.1 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 10 to 15 pounds per 1000 square feet.

Synthetic Granular Fertilizer 10 to 15 pounds per 1000 square feet.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. Anchor each piece of sod with wood pegs or wire staples maximum 2 feet on center. On slope areas, start sodding at bottom of the slope.

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 GRASS ESTABLISHMENT

3.4.1 General

The period of grass establishment shall begin immediately after the completion of sodding in an area and shall continue for a period of 2 months after the completion of sodding on the entire project unless the desired grass cover is established in a shorter period of time and shortening of the grass-establishment is authorized.

3.4.2 Watering

Provide and maintain temporary piping and lawn-watering equipment required to convey water from the water source to uniformly water the grassed areas. Water shall be free from substances detrimental to the growth of vegetation. Water sources located on Government property will be subject to approval prior to use. Temporary water equipment shall be removed after grass area acceptance.

Watering schedules shall be arranged and lawn-watering equipment laid out in a manner to avoid the necessity of walking over muddy and newly grassed areas.

After the initial watering, the grassed areas shall be watered as required to maintain the soil in a moist condition for the entire grass-establishment period.

3.4.3 Mowing

When the average height of grass reaches 2-1/4 inches, sodded lawn areas shall be mowed with approved mowing equipment to a grass height of 1-1/2 inches. When the amount of cut grass is heavy, the cuttings shall be removed to prevent smothering the grass.

When the average height of grass reaches 8 inches, areas shall be mowed with approved mowing equipment to a grass height of 4 inches.

3.4.4 Weeding

Weeds or other undesirable vegetation that threaten to smother the grass shall be uprooted and removed from the area.

3.4.5 Resodding

The area on which an acceptable stand of grass is not present shall be sodded as specified for the original planting. An acceptable stand of living grass from at least 90 percent of the sod placed according to this specification. Areas on which there is not an acceptable stand of grass shall continue to be replanted throughout the following year until an acceptable stand of grass is present.

3.5 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

3.6 ACCEPTANCE REQUIREMENTS

3.6.1 Acceptance Requirements

Completed grass areas shall have been recently mowed and be covered with a uniform stand of the specified grass, be free of rank growths of weeds or other undesirable vegetation, and be free of irregular surface changes and other depressions where water will accumulate.

Scattered bare spots not larger than 6 inches in any dimension will be allowed, up to a maximum of 3 percent of any grass area.

Condition of grass areas at the time of inspection will be noted and a determination made whether the grass-establishment period shall be extended for any area.

3.6.2 Repairs

If, before completion and final acceptance of the facility, portions of the surface become gullied or otherwise damaged, the grass areas having been destroyed, the affected area shall be repaired to re-establish the condition and grade of the soil prior to sodding and then re-sodded, and the grass established as specified.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 01 99

SLIP LINING (CIPP) OF EXISTING PIPING

-- End of Section Table of Contents --

SECTION 33 01 99

SLIP LINING (CIPP) OF EXISTING PIPING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 638	(2010) Standard Test Method for Tensile Properties of Plastics
ASTM D 790	(2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM F 1216	(2009) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
ASTM F 1743	(2008) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9000	(2005) Quality Management Systems - Fundamentals and Vocabulary

1.2 SYSTEM DESCRIPTION

This section consists of the requirements and work needed to rehabilitate existing pipes by furnishing and installing pipe liners by the method of cured in place pipe (CIPP) slip lining. Use pipe liners of the sizes, types, design, and dimensions shown on the plans, and include all connections, joints, and other appurtenances as required to complete the work.

Specified in this section are requirements of CIPP slip lining of existing pipelines, including but is not limited to the following:

Cleaning

Flow diversion and temporary works

CCTV Inspection

Traffic management

Pipe lining fabrication, storage and placement

Service connections, connecting to access chambers and make water tight

Grouting

Testing

Reinstatement

1.2.1 Design Requirements

1.2.1.1 Gravity Sewer

Provide cured in place pipes designed to allow the maximum conveyance capacity possible.

The CIPP shall be designed as per ASTM F 1216, Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall.

The Contractor must have performed long-term testing for flexural creep of the CIPP pipe material installed. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (Tube and Resin) and general workmanship of the installation and curing. A percentage of the instantaneous flexural modulus value (as measured by ASTM D 790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. Retention values exceeding 50% of the short-term test results shall not be applied unless substantiated by qualified third party test data to the Government's satisfaction. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

The Enhancement Factor 'K' to be used in 'Partially Deteriorated' Design conditions shall be assigned a value of 7. Application of Enhancement (K) Factors in excess of 7 shall be substantiated through independent test data to the satisfaction of the Government.

The layers of the CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If the layers separate during field sample testing, new samples will be required to be obtained from the installed pipe. Any reoccurrence may cause rejection of the work.

The CIPP material for pipes up to 24-inch diameter shall conform to the structural properties, as listed below. For pipe diameters over 24 inches, use liner and resin calculation for I Plus composite as developed In Situ Form Technologies, Inc. or approved equal.

MINIMUM CIPP PHYSICAL PROPERTIES

Property	Test Method	Cured Polyester Composite	
		Min per ASTM F 1216	Enhanced Resin
Modulus of Elasticity	ASTM D 790	250,000 psi	400,000 psi
Flexural Stress	ASTM D 790	4,500 psi	4,500 psi

The required structural CIPP wall thickness shall be based 6 mm.

1.2.1.2 Pressurized Water

The CIPP shall be designed as in accordance with ASTM F 1216, Appendix X1.3.2 for the Fully Deteriorated Pressure Pipe condition and shall be provided as a prequalification submittal. These detailed calculations shall provide the input data as well as the actual calculation for Eqs X1.1, X1.3, X1.4, and X1.7 of Appendix X1 of ASTM F 1216. The design submittal shall also clearly identify the physical properties used for design.

Other than what is allowed in ASTM F 1216, the CIPP design shall assume no contribution from the original host pipe.

The design of the CIPP shall be based on the following parameters:

Diameter	12 inch
Internal Design Pressure	150 psi
Soil Depth (above invert)	3 feet
Ground Water Depth (above invert)	3 feet
Type of Live Load	AASHTO H20 Loading
Modulus of Soil Reaction	100 pci
Soil Density	90 percent Modified Proctor Maximum Dry Density ASTM D 1557

The physical properties used in the design submittal shall be clearly identified. At a minimum, the CIPP shall have the following physical properties:

PROPERTY	TEST METHOD	MINIMUM VALUE*
Initial Flexural Modulus of Elasticity	ASTM D 790	300,000 psi
Initial Flexural Strength	ASTM D 790	7,000 psi
Initial Tensile Strength	ASTM D 638**	6,500 psi

*Values are for design conditions at 75 degrees F.

**For materials that do not allow sufficiently accurate hoop/weft testing per ASTM D 638, initial tensile strength may also be substantiated by short-term burst testing results.

1.2.2 Performance Requirements

Notify the Contracting Officer 24 hours in advance of tests, and perform tests at the work site if practicable. Conform to local, state, and federal requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

List of proposed subcontractors; G
List of proposed products; G
Construction Progress Schedule; G
Manufacturer's Certification of Florida Product Approval

SD-02 Shop Drawings

Survey of Pipe Locations

Submit manufacturer's detailed product data with complete information on pipeline materials, physical properties, and dimensions. Include a manufacturer's certificate of compliance with specifications for proposed materials.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Cured in Place Pipes

SD-06 Test Reports

After liner installation, perform a hydrostatic test in accordance with ASTM F 1216 before the liner has been completely sealed into place. Check integrity of joints and verify that liner has not been damaged during installation. Repair if needed using liner manufacturer's recommended procedure and retest for leaks.

SD-08 Manufacturer's Instructions

Manufacturer's recommendations for shipping, handling, erection procedures, and care and maintenance upon completion of installation.

SD-09 Manufacturer's Field Reports

Manufacturer's Certification of Installation

1.4 QUALITY ASSURANCE

1.4.1 Survey of Pipe Locations

Submit a certified survey meeting the requirements specified herein.

1.4.2 Qualifications

1.4.2.1 Gravity Sewer

Products and installers must meet all of the following criteria to be deemed Commercially Acceptable:

For a Product to be considered Commercially Proven, a minimum of 1,000,000 linear feet or 4,000 manhole-to-manhole line sections of successful wastewater collection system installations in the U.S. must be documented to the satisfaction of the Government to assure commercial viability

For an Installer to be considered as Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Government, and must have had at least 5 (five) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 50,000 feet of the product bid in wastewater collection systems. Acceptable documentation of these minimum installations must be submitted to the Government.

Sewer rehabilitation products submitted for approval must provide third party test results supporting the structural performance (short-term and long-term) of the product and such data shall be satisfactory to the Government. Test samples shall be prepared to simulate installation methods and trauma of the product. No product will be approved without independent third party testing verification.

Both the rehabilitation manufacturing and installation processes shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.

1.4.2.2 Pressurized Water

For a Product to be considered Commercially Proven, a minimum of 25,000 linear feet of successful water distribution system installations in the United States must be documented to the satisfaction of the Government to assure commercial viability.

For an Installer to be considered Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Government and must have had at least 5 (five) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 25,000 linear feet of the product bid in the water distribution systems. Acceptable documentation supporting the above must be submitted to the Government.

Water rehabilitation products submitted for approval must provide third party test results supporting the structural performance (short-term and long-term) of the product and such data shall be satisfactory to the Government. Test samples shall be prepared to simulate installation methods and trauma of the product. No product will be approved without independent third party testing verification.

Both the rehabilitation manufacturer and installation processes shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.

All required submittals must be satisfactory to the Government.

1.4.3 Pre-Installation Conference

At the Pre-installation conference provide, for approval, submit the following:

a. List of proposed products showing existing pipe diameters, with samples of the liner and resins

b. List of measured pipe diameters of each sewer segment to be lined with CIPP

c. Dates of liner placement,

d. Proposed Construction Progress Schedule

e. List of proposed subcontractors

f. Manufacturer's Certification of Florida Product Approval

1.5 DELIVERY, STORAGE, AND HANDLING

Prevent injury or abrasion to CIPP during loading, transportation, and unloading.

1.6 SEQUENCING AND SCHEDULING

Submit plan for final approval of construction sequence and schedule prior to commencing construction.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Gravity Sewer Tube

The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F 1216, Section 5.1 or ASTM F 1743, Section 5.2.1 The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.

The wet out tube shall have a relatively uniform thickness so that when compressed at installation, pressures will equal or exceed the calculated minimum design thickness.

The tube shall be manufactured to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be utilized.

The outside layer of the tube shall be coated with an impermeable, flexible membrane that will contain the resin and all the resin impregnation (wet out) procedure to be monitored.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.

The wall color of the interior pipe surface of CIPP after installation shall be a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

Seams in the tube shall be stronger than the non-seamed felt material.

The tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the Manufacturers name or identifying symbol. The tubes must be manufactured in the United States. Liner materials shall be as manufactured by In situ Form Technologies, Inc. or approved equal.

2.1.2 Gravity Sewer Resin

The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy system including all required catalysts, initiators or hardeners that when cured within the tube create a composite that satisfies the requirements of ASTM F 1216 and ASTM F 1743, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

2.1.3 Pressurized Water Tube

The CIPP product shall consist of one or more layers of absorbent woven and/or non-woven synthetic fiber, with or without glass fiber reinforcement, which is impregnated with an epoxy resin system that is compatible with the installation process being used. The product shall meet the requirements of ASTM F 1216.

The tube shall be fabricated to dimensions such that when installed will fit tightly to the internal circumference of the host pipe being lined, making allowance for stretching during installation.

In the installed state, the inside layer of the tube shall be coated with a translucent, flexible plastic materials that acts to separate the curing heat medium from the thermoset resin system undergoing cure.

The tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the minimum required thickness specified in the design submittals.

Fabricate tube from materials which, when cured, will be chemically resistant to internal exposure to drinking water treated with common chemical additives.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. The tube shall contain reinforcement (glass, woven fiber, or equal) in order to withstand the internal pressure design requirements.

The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color so that a clear detail examination may be made of the final product.

Materials that are defective, damaged or otherwise deemed unacceptable for use prior to installation shall be rejected and replaced at the Contractor's expense. Liner materials damaged during installation shall be repaired or replaced as recommended by the Contractor and approved by the Government.

PART 3 EXECUTION

3.1 PREPARATION

Complete the following preparations, unless approved otherwise by the Contracting Officer. The Contracting Officer makes no guarantee regarding the information, data, and physical condition of underground facilities or existing pipe lines. Before commencing with any work, or ordering any materials, physically measure and perform CCTV inspection of the existing pipe line to verify that the rehabilitation specified herein is appropriate.

3.1.1 Safety

Carry out all operations in strict accordance with all applicable OSHA Standards. Particular attention is directed to those safety requirements involving entry into a confined space. It is the Contractor's responsibility to familiarize themselves with OSHA Standards and Regulations pertaining to all aspects of the work.

It shall be the responsibility of the Government to locate and designate all manhole access points open and accessible for the work, and provide rights-of-access to these locations. If a street must be closed to traffic because of the orientation of the sewer, the Government shall institute the actions necessary to provide access during this for the mutually agreed time period. The Government shall also provide free access to water hydrants for cleaning, installation and other process related work items requiring water.

3.1.1.1 Cleaning of Sewer Lines

The Contractor shall perform internal pipe cleaning no more than 48 hours before lining and remove all internal debris out of the sewer line that will interfere with the installation of CIPP. The Government shall also provide a dumpsite for all debris removed from the sewers during the cleaning operation. Unless stated otherwise, it is assumed this site will be at or near the sewage treatment facility to which the debris would have arrived in absence of the cleaning operation. Any hazardous waste material encountered during this project will be considered as a changed condition.

3.1.1.2 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for repair. All service laterals in the line or line sections being lined shall be addressed as part of the bypass plan. The pump(s) and bypass line(s) shall be of adequate capacity to accommodate the sewage flow. The Government shall require a detailed bypass plan to be submitted.

3.1.1.3 Inspection of Pipelines

Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections using close circuit television (CCTV) inspection techniques. The pipeline interior shall be carefully inspected to determine the location of any conditions that may prevent proper installation of CIPP. These shall be noted and corrected. A DVD or videotape and suitable written log for each line section shall be submitted for later reference by the Government.

3.1.1.4 Line Obstructions

It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the installation process, that was not evident on the pre-bid video and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Government's representative prior to the commencement of the work and shall be considered as a separate pay item.

3.1.1.5 Public Notification

The Contractor shall make every effort to maintain sewer service usage throughout the duration of the project. In the event that a connection will be out of service, the longest period of no service shall be 8 hours. A public notification program shall be implemented, and shall as a minimum, require the Contractor to be responsible for contacting each affected facility connected to the sanitary sewer and informing them of the work to be conducted, and when the sewer will be off-line. The Contractor shall also provide the following:

Written notice to be delivered to each affected facility the day prior to the beginning of work being conducted on the section, and a local telephone number of the Contractor they can call to discuss the project or any potential problems.

Personal contact with any home or business, which cannot be reconnected within the time stated in the written notice.

The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing the CIPP.

3.2 INSTALLATION

3.2.1 Gravity Sewer

CIPP installation shall be in accordance with ASTM F 1216, Section 7, or ASTM F 1743, Section 6, with the following modifications:

Resin Impregnation - The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin during installation through cracks and irregularities in the original pipe wall.If a vacuum impregnation process is used, the point of vacuum shall be no further than 25-feet from the point of initial resin introduction. After vacuum in the tube is established, a vacuum point shall be no further than 75-feet from the leading edge of the resin. The leading edge of the resin slug shall be as near to perpendicular to the longitudinal axis of the tube as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the Installer uses an alternate method of resin impregnation, the method must produce the equivalent results. Any alternate resin impregnation method must be documented to the Government's satisfaction that the saturation of the CIPP is sufficient.

Tube Insertion - The wet out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.

Temperature gauges shall be placed between the tube and the host pipe's invert position to monitor the temperatures during the cure cycle.

Curing shall be accomplished by utilizing hot water under hydrostatic pressure or steam pressure in accordance with the manufacturer's recommended cure schedule.

3.2.2 Pressurized Water

3.2.2.1 Project Planning

The Government shall ensure access to the existing water mains. The Contractor shall provide adequate notice to the Government prior to mobilization. The Government will notify customers and local fire department following receipt of the Contractor's notice.

The Government will operate all water main valves, curb stops, and fire hydrants. The Contractor will provide to the Government a specific time and date when the individual water services will be transferred from the water main to the temporary bypass piping system.

Water necessary for cleaning, disinfection, and flushing will be available, at no cost, from locations (fire hydrants) indicated by the Government prior to the start of Work. Water source provided shall be close to lines being worked on. The Contractor shall provide necessary piping or flexible hoses, fittings, and approved reduced pressure zone backflow prevention device for connection between fire hydrant and end of pipe section where water is required. The Government shall provide a location at no cost to the Contractor (e.g., sanitary sewer, etc.) for proper disposal of water after use.

3.2.2.2 Access, Cleaning, and Inspection

Prior to entering any permit required confined space, the Contractor shall evaluate the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen. This shall be undertaken in accordance with local, state, or federal safety regulations.

The Contractor shall identify the number and location of access points required. The Government shall provide rights of access to the pipeline. The Contractor or Government, as specified in the contract documents, shall provide the excavation, pipe work, reconnection, and restoration for access points.

Immediately upon opening the host main at the access points and prior to installation of liner, the ends of the adjacent existing water main that are not to be lined at the insertion/extraction points shall be covered/plugged by the Contractor so that no debris shall enter into them during reconstruction work.

The Contractor shall remove all internal debris out of the pipeline that will interfere with the installation. Pipes shall be cleaned by the Contractor, as needed, with high-velocity jet cleaners, mechanically powered equipment, cable-attached devices or fluid-propelled devices (e.g., pipe pigs). If required the Government shall provide a dump site for all debris removed from the pipe during the cleaning operation. Unless specified otherwise, this site shall be at or near the project site. Any hazardous waste material encountered during this project shall be considered as a changed condition.

Verification of readiness to install liner shall be performed by experienced personnel trained in locating services, breaks, obstacles, etc., This may include pipe mandrels or other devices up to and including closed-circuit television or man entry. The interior of the pipeline shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube. A videotape or suitable log shall be kept for reference. It will be the Government's responsibility to remove any unforeseen obstructions that may prevent liner installation. The Government may direct the Contractor to remove these obstructions and reimburse under the terms of the contract.

Any external water leaking back into the existing pipeline shall be kept to a minimum so as not to interfere with the proper installation and cure of the CIPP liner.

The Contractor shall field verify the length of water main sections to be cleaned and lined.

The Contractor shall isolate or remove any air release valves from water main section prior to liner installation.

The Contractor shall flush the host pipe with clean water to remove any loose debris from the pipe surface. Wherever practical, remove all standing water from the inside surfaces of the cleaned water main by passing a sufficient number of oversized foam swabs through the main or use a progressive expansion method to remove standing water.

The Contractor shall remove and dispose of any waste or debris generated by the cleaning operation to a site furnished by the Government.

3.2.2.3 Television Inspection

When required the Contractor shall perform closed-circuit television inspection of existing water mains at two intervals: prior to water main lining and upon completion of the lining process. The Contractor shall provide the Government with a complete set of all DVDs. The picture quality and definition shall be acceptable for viewing, and the DVDs shall be compatible with standard DVD equipment. Information on the DVD shall identify the water main section, direction of taping, and the date of inspection. Where applicable, the DVDs shall include a voice description of the location of any identified defects.

3.2.2.4 Resin Impregnation

The tube shall be impregnated (wet out) with resin under controlled conditions. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in the original pipe wall.

The Contractor shall allow the Government to inspect the materials and procedures used to impregnate the tube.

3.2.2.5 Installation

The wet out tube shall be inserted through an approved access point by a pull-in place method or a direct inversion process, or a combination of the two. The head used to extend the liner tube though the length of pipe being rehabilitated shall be sufficient to fully extend the tube both circumferentially and longitudinally.

Before the installation begins, the Contractor shall determine the minimum pressure required to hold the tube tight against the existing pipeline and the maximum allowable pressure so as not to damage the tube. To ensure a proper fit of the CIPP tube to the host pipe, the pressure shall be maintained between the minimum and maximum pressures until the installation has been completed.

The use of a lubricant during the installation process may be needed to reduce friction. The lubricant used shall be a nontoxic, FDA or NSF certified product.

3.2.2.6 Curing

After installation is completed, a suitable heat source and related equipment shall be used to circulate heated water or injected steam throughout the pipeline. The equipment shall be capable of delivering hot water or steam throughout the pipeline to uniformly raise the temperature above the temperature required to affect a cure of the resin. Water or steam temperature in the line during the cure period shall be as determined by the Contractor.

The heat source shall be fitted with suitable monitors to gauge the temperature of the hot water or steam supply. To determine the temperatures during the cure cycle, a gauge shall be placed at the beginning and termination points of the section being lined. The temperature sensing device shall be placed between the impregnated tube and the invert of the existing pipe.

Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature shall be held at the post-cure temperature for a period as determined by the Contractor. The curing process shall take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

3.2.2.7 Cool-Down

Cool-down shall be accomplished by introducing cool water to replace water being drained from the system or by introducing air to replace the steam used in a steam cure. Care shall be taken in the release of the internal head so that a vacuum that could damage the newly installed CIPP will not be developed.

3.3 REINSTATEMENT OF BRANCH CONNECTIONS

3.3.1 Gravity Sewer

It is the intent of these specifications that branch connections to buildings be re-opened without excavation, utilizing a remotely controlled cutting device, monitored by a CCTV. Restore 95 percent of the opening, retrieve coupons, and smooth opening. The Contractor shall certify a minimum of two complete functional cutters plus key spare components are on the job site before each installation or are in the immediate area of the jobsite and can be quickly obtained. Unless otherwise directed by the Government or his authorized representative, all laterals will be reinstated. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

3.3.2 Pressurized Water

Prior to installation of the liner, the Contractor shall locate all existing service connection and plug or prepare the corporation valve connections as recommended by the manufacturer. All plugs shall be sized for the respective water taps. The service plugs used in this process shall be able to withstand the temperatures expected during the cure of up the CIPP.

After the lining is complete, reconnect existing services from the interior of the water main using a television camera directed robotic cutting device that removes a small, circular section of the liner to expose the corporation valve opening. A water-tight seal is provided by direct resin-to-host pipe adhesion.

Reconnections shall be free of burrs, frayed edges, and other restrictions preventing free water flow and shall be opened to the size of their original diameter and to a depth required to completely open the water service connection to the residence served.

3.4 INSPECTION

3.4.1 Gravity Sewer

CIPP samples shall be prepared and physical properties tested in accordance with ASTM F 1216 or ASTM F 1743, Section 8, using either method proposed. The flexural properties must meet or exceed the values listed in Table 1 of the applicable ASTM.

Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F 1743. The minimum wall thickness at any point shall not be less than 87.5 percent of the minimum design wall thickness of 6 mm.

Visual inspection of the CIPP shall be in accordance with ASTM F 1743, Section 8.6.

Post-lining internal television inspection shall be performed within 24 hours of CIPP curing. All defects located shall be repaired as approved by the Government. A DVD or videotape of the internal inspection shall be submitted before line section identification.

3.4.2 Pressurized Water

After liner has been cooled down and before opening the service laterals, a preliminary television inspection of the newly installed liner may be performed to determine that the liner is properly installed.

The finished lining shall be continuous over the entire length and be free from visual defects such as foreign inclusions, dry spots, lifts, pinholes and delaminations. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.

3.5 TESTING REQUIREMENTS

3.5.1 Chemical Resistance

The CIPP shall meet the chemical resistance requirements of ASTM F 1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical-testing requirements.

3.5.2 Hydraulic Capacity

Overall, the hydraulic cross-section shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

3.5.3 CIPP Field Samples

When requested by the Government the Contractor shall submit test results from field installations in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPP physical properties specified in Minimum CIPP Physical Properties table in the paragraph titled "Design Requirements" have been achieved in previous field applications. Samples for this project shall be made and tested as described in the article titled "INSPECTION."

3.5.4 Pressure Testing for Water-Tightness

Pressure testing for water tightness shall be provided on all CIPP sections identified by the Government in the contract documents or purchase order and shall be completed after inspection but before the reinstatement of service connections.

Perform hydrostatic pressure test on the lined water main, following the guidelines of ASTM F 1216, Section 8.3. The test section shall be subjected to a hydrostatic pressure of no more than 1-1/2 times the operating pressure of 150 psi.

As noted in ASTM F 1216, the allowable leakage during the pressure test shall be 20 U.S. gallons per inch of internal pipe diameter per mile of pipe per day (GIDMD), providing that all the air has been evacuated from the line prior to testing and the structural pipe lining system has cooled down to ambient temperature.

After the one hour test, the quantified make-up water shall be extrapolated to the 24-hour rate for comparison purposes. Any visible leakage at termination points shall be eliminated. If not feasible or possible at the time of the test, the termination point leakage shall be kept to a minimum, collected and then deducted from the actual make up water rate. If the loss at test pressure exceeds the allowable, the Contractor shall endeavor to identify the source of the loss and minimize it in a manner acceptable to the Government. Trapped air can significantly affect internal pressure and may require extensive continued testing until stabilization occurs. The pressure test for water tightness shall be deemed acceptable if that actually measured during the one-hour test (which has been extrapolated to a 24-hour day rate) is equal to or less than the allowable make up water rate of 20 GIDMD.

3.6 CLEAN-UP

The work area shall be maintained and kept clean throughout the work. Upon acceptance of the installation work and testing, the Contractor shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

After project completion, the Contractor shall return the piping system to service by closure of all access pits with appropriate pipe spools, valves, and other relevant pipe fittings.

Upon acceptance of the installation, the Contractor shall coordinate with the Contracting Officer to reinstate the project area affected by the operations.

3.7 INSTALLATION CERTIFICATION

Submit a signed copy of the Manufacturer's Certification of Installation to the Contracting Officer upon completion of final inspection.

-- End of Section --

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BORING AND JACKING

-- End of Section Table of Contents --

SECTION 33 05 23.16

BORING AND JACKING

PART 1 GENERAL

1.1 DEFINITIONS

Carrier Pipe: Sewer or water pipe as shown on the drawings.

Casing Pipe: Sleeve through which carrier pipe will be placed.

Boring and Jacking: Method of installing casing pipe by cutting, hand mining, or boring an opening in soils material, simultaneously forcing casing pipe through it with hydraulic jacks.

Casing Spacer: Fabricated item for positioning a carrier pipe inside a casing pipe.

Access pits: Jacking and receiving shafts constructed at both ends of the pipe length to be installed by trenchless installation operations.

1.2 SCOPE OF WORK

The Contractor shall provide all labor, materials, equipment, supplies, and incidentals required to install casing pipe and carrier pipe by boring and jacking at the locations shown on the contract drawings and as specified in this Section. The method of installation selected by the Contractor shall be capable of penetrating through soil, partially weathered bedrock, weathered bedrock, competent bedrock, and boulders.

Work shall be done in strict accordance with all State and local laws and regulations and requirements.

The Contractor shall make such subsurface investigations as he deems necessary for each casing installation. The Contractor shall be solely responsible for determining the nature of the subsurface materials at each casing installation and for selecting the untrenched casing installation method. Under no circumstances shall the Government pay additional costs related to unanticipated subsurface conditions.

The Contractor is required to follow all OSHA regulations regarding confined space for casing installation. The Contractor is required to obtain all permits required associated with OSHA regulations and requirements for confined space entry.

1.3 RELATED WORK

01 57 20.00 10 ENVIRONMENTAL PROTECTION
03 30 00 CAST-IN-PLACE CONCRETE
31 00 00 EARTHWORK
33 11 00 WATER DISTRIBUTION
33 71 02.00 20 UNDERGROUND ELECTRICAL

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ANSI/ASSE A10.16	(1995; R 2001) Safety Requirements for Tunnels, Shafts, and Caissons

ASTM INTERNATIONAL (ASTM)

ASTM A 666	(2003) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A 1011/A 1011M	(2009b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 404	(2007) Standard Specification for Aggregates for Masonry Grout

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

FDOT Spec 121	(2010) Flowable Fill

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Proposed methods of trenchless installation

SD-02 Shop Drawings

Submit shop drawings (G) in accordance with the paragraph entitled "SHOP DRAWINGS."

SD-05 Design Data

Design mixes and design calculations for concrete, grout, and flowable fill.

The Contractor's Engineer shall submit copies of design calculations for the information to the Contracting Officer.

SD-07 Certificates

Qualifications of the trenchless installation contractor and engineer in accordance with the article entitled "QUALIFICATION."

1.6 SHOP DRAWINGS

Shop drawings shall include the following:

Shop drawings for casing pipe showing sizes and hold down assemblies or casing spacers for carrier pipe.

Shop drawings of bulkheads when shown on the drawings.

Working drawings and written procedures describing in detail proposed bore-and-jack method and entire operation to be used, including but not limited to:

Working and receiving shafts.
Dewatering.
Method of removing soils and installation of casing and carrier pipe.
Size, capacity, and arrangement of equipment.
Backstop.
Shaft base material.
Type of cutter head.
Method of monitoring and controlling line and grade.
Detection of surface movement.
Procedure for installing pipe supports or anchors.
Bulkhead details and proposed positive method of anchoring carrier pipe to prevent flotation.
Catalog data for casing spacers when used for temporary support during construction.
Procedure for monitoring line and grade.

If modifications to methods are required during construction, submit working drawings delineating modifications, including reasons for them.

1.7 DELIVERY, STORAGE, AND HANDLING

Unload and handle materials with equipment of adequate capacity.

Store materials on site in a reasonably level well-drained area free from brush.

Store individual pieces and bundles with safe walking space between to allow full view for inspection.

1.8 PROJECT CONDITIONS

Bore to avoid interfering with, interrupting, or endangering the surface and activity thereon.

Minimize subsidence of surface, structures, and utilities above and in the vicinity of bore.

Support ground continuously to prevent loss of ground and keep perimeters stable.

Be responsible for settlement resulting from operations.

Repair and restore damaged property to its condition before being disturbed at no cost to the Government.

Comply with applicable ordinances, codes, statutes, rules, and regulations of State of Florida, Kennedy Space Center, and applicable regulations of Federal Government, 29 CFR 1926, and applicable criteria of ANSI/ASSE A10.16.

1.9 QUALIFICATIONS

Qualifications of the trenchless installation Contractor:

Name, business, address, and telephone number of the Contractor.

Experience in successfully constructing pipelines by the method proposed to be used to install the trenchless installation pipe for this project.

List of similar projects for the last 2 years including the name of contact person and telephone number.

Certification of workman training.

Name(s) of all supervisory personnel to be directly involved with the project.

The Contractor shall sign and date the information provided and certify that to the extent of his knowledge, the information is true and accurate, and that the supervisory personnel for the trenchless installation operations will be directly involved with this project. Substitutions of personnel and/or methods will not be allowed without the written authorization of the Contracting Officer.

The Contractor shall engage the services of a Professional Engineer registered in Florida to design each trenched and untrenched casing system, including shafts, sheeting, bracing, grouting, dewatering, soil stabilization, and jacking system which the Contractor proposes for installation. Submittals shall be prepared by a Licensed Professional Engineer registered in Florida and having a minimum of 5 years of professional experience in the design and construction of similar jacking systems.

1.10 ADDITIONAL CRITERIA FOR WORK UNDER RAILROADS

Do not schedule work within and adjacent to railroad property until the Contracting Officer and the Government approve submittals, including proper insurance. Approval does not relieve the Contractor of responsibility for adequacy and safety of procedures.

Place safety, precautionary, and protective devices and services required by the Government before work proceeds.

PART 2 PRODUCTS

2.1 CASING PIPE

General: Use casing pipe following the drawings.

Steel Pipe:

Smooth-walled steel pipe with minimum yield strength of 36,000 psi (ASTM A 1011/A 1011M Grade 36).

Minimum wall thickness: 3/8 inch or following drawings and/or Bid Schedule.

Inside diameter: as shown on the drawings as a minimum.

Joints: Fully welded around circumference of pipe with complete penetration weld.

Weld of sufficient strength to withstand forces at pipe joints without any distortion of pipes.

Minimum welds: Follow the drawings.

Coating: Fusion-bonded epoxy.

2.2 CARRIER PIPE

Carrier Pipe: For water service, specified in 33 11 00 WATER DISTRIBUTION. For sewer service, specified in 33 30 00 SANITARY SEWERS.

2.3 CASING SPACERS

Fusion bond assembled carbon-steel bands, risers, and studs with PVC or Epoxy 14 to 20 mils thick.

Treat and coat stainless-steel metal surfaces and welds to reduce the chemical reactivity of the surfaces.

Bands and Risers:

Minimum two pieces, stainless-steel plate: ASTM A 666 Type 304, or hot rolled, pickled carbon steel with a minimum yield strength of 30,000 psi and coat as specified in this Section.

Band: Minimum thickness: 14 gauge for carrier pipes up to 12 inches diameter and 12 gauge for more than 12 inches.

Runners:

High-density molecular polyethylene or polymer-reinforced fiberglass with DURO Hardness A of 80 and minimum dielectric strength of 500 volts per mil with sufficient compressive and shear strengths.

Attach to risers with bolts or welded studs.

Fill bolt holes with silicone caulk.

Spacer Band: Line with minimum 0.090-inch-thick ribbed PVC liner of DURO Hardness A of 80 and minimum dielectric strength of 450 volts per mil.

Approved Manufacturers:

Pipeline Seal and Insulator Inc.

Cascade Waterworks Manufacturing Company.

Or equal (Minimum 5 years of fabricating casing spacers in the United States).

2.4 CASING END SEALS

Approved Manufacturers:

Advance Products & Systems, Model AC.

Pipeline Seal & Insulator, Inc., Model S or C.

Maloney Technical Products, MULTIFLEX End Seal.

Or equal.

2.5 GROUT

Cement: ASTM C 150, Type I or Type II.

Water: See Section 03 30 00 CAST-IN-PLACE CONCRETE.

Sand: ASTM C 404, Size No. 1.

Voids Between Casing and Existing Ground: Minimum compressive strength of 100 psi, attained within 24 hours, and sufficiently fluid to inject through lining and fill voids, with prompt setting to control grout flow.

2.6 CONCRETE

Concrete for cradle or filling void between casing and carrier pipe: See Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7 FLOWABLE FILL

For Filling Void between Casing and Carrier Pipe: Excavatable flowable fill in accordance with FDOT Spec 121.

2.8 BULKHEADS

As required.

PART 3 EXECUTION

3.1 GENERAL

Limited site soil investigation was performed and may be obtained for casing pipe design are available.

Interpret this material and investigate work site soil conditions before bidding.

Encountering rock or water will not entitle the Contractor to additional compensation.

Notify the Contracting Officer immediately if obstructions stopping forward motion of operation are encountered during installation.

When it is impossible to advance bore hole or pipe, discontinue operation, abandon completed portion in place, and fill with grout or plug unless otherwise directed by the Contracting Officer.

Dewatering: See Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.2 PREPARATION

Refer to Section 01 57 20.00 10 and Drawing Number EN2 for requirements when working in sites with potential contamination and environmental issues.

Excavate Shafts: Follow the drawings and this specification.

Perform preliminary work, including constructing backstop, placing guide timbers, and placing boring apparatus.

3.2.1 Reporting

Report settlement or movement immediately to the Contracting Officer and take immediate remedial action.

3.3 SHAFT CONSTRUCTION

Construction of jacking and receiving shafts shall be constructed in accordance with the submitted design, equipment, and procedure so that the casing pipe can be installed to the alignment shown and the carrier pipe can be installed without damage.

The jacking shaft shall be of adequate length to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, and the jacking pipe. The shaft shall be sufficiently wide to allow ample working space on each side of the jacking frame and pipe and for materials brought into the shaft and excavation removed. The depth of the shaft shall be such that the invert of the pipe, when placed on the guide frame, will be at the elevation desired for the casing.

The shaft shall be kept free of water at all times by deep wells, well points, or sump pumping where conditions permit. Dewatering through the casing pipe during construction shall not be permitted. Observed water levels before construction shall be below the invert elevation of the jacking shafts. Additional groundwater controls may be ordered on short notice and shall be implemented as directed.

Jacking and receiving shafts shall be designed by the Contractor's engineer in accordance with the requirements of OSHA excavation safety standards (29 CFR 1926.650 Subpart P) and all local and state requirements. The shaft jacking faces shall be designed to transfer all jacking forces safely into the earth evenly. Shafts shall be designed to resist all pressures developed by the soil outside the shaft. Shafts shall be constructed with steel sheeting and bracing. Shaft walls shall terminate not less than 3 feet 6 inches above existing grade.

Steel rails or beams securely supported shall be used in the shaft for placement and alignment of the jacking equipment and of each piece of casing pipe during installation. Jacking shall not begin until the Contractor's surveyor has verified in writing to the Contracting Officer that the first casing segment is at the correct location and elevation and is oriented at the correct horizontal and vertical direction. After the first segment has been jacked forward, the Contractor's surveyor shall again verify in writing to the Contracting Officer that alignment is correct. If alignment is not correct at this point or any successive point, the jacked casing operation shall be stopped and shall not resume until the Contractor has modified the jacking operation as required to maintain proper alignment at no additional cost to the Government.

All components of the shafts shall be completely removed after the casing is installed, including breaking up, removing, and disposing of concrete, if used, and removing or cutting off sheeting. The bottom of the shaft shall be brought to standard trench depth for pipe installation or additional casing installation with structural fill. Pipe bedding and backfill shall be as shown.

3.4 BORING OPERATION AND CASING PIPE INSTALLATION

3.4.1 General

The casing pipe at each location shown on the drawings shall be jacked in one continuous 24-hour-per-day operation. In no event shall jacking or lubricant injection be discontinued for a sufficient period to cause the partially jacked sleeve to "freeze" in place. Proper alignment and elevation of the casing shall be consistently maintained throughout the jacking operation.

Use removable auger and cutting head arrangement.

Control line and grade.

3.4.2 Boring and Jacking

Jack casing pipe with auger rotating within pipe to remove spoil.

Hand mining may be used for large bore casing pipe, provided the method is submitted in detail and is acceptable to the Contracting Officer.

Maintain the face of the cutting head to preclude free flow of soft or poor soils material.

Overcut of Cutting Head:

Not to exceed outside diameter of casing pipe by more than 1/2 inch.

For hand mining no overcut will be permitted.

Use positive means for continuous monitoring and controlling grade of casing pipe during boring operation.

Weld steel pipe casing as required in this Section.

When coating is required, repair coating damage on each side of weld and recoat complete weld area.

Minimize the occurrence of voids outside the casing pipe and excavate at the excavation face in a manner to minimize voids. All voids between the jacked casing and the earth or rock shall be filled with pumped lubricant during jacking.

Suitable transport and hoisting equipment shall be provided to remove the excavated material from the casing and shafts.

The Contractor shall dispose of the excavated material off site.

The carrier pipe shall not be installed until leakage into the casing pipe, after removal of all dewatering pumping systems, does not exceed 2.0 gal/hour maximum.

Disposal of Wastes and Groundwater

The Contractor shall dispose of all waste soils, slurries, and other wastes in accordance with all applicable Federal, State, and County regulations. No waste will be left on-site following completion of the work.

The Contractor shall dispose of all groundwater generated by dewatering operations and any surface water entering access shafts in accordance with the approved soil and erosion control plan.

3.6 FIELD QUALITY CONTROL

Maintain line and grade following drawings to within 2-inch tolerance.

3.5 INSTALLATION OF CARRIER PIPE

Install carrier pipe following Sections 31 00 00 EARTHWORK, Section 33 11 00 WATER DISTRIBUTION, standard details, and drawings.

Use thermoplastic or other dielectric material (except wood) between carrier pipe and tunnel liner plate or steel sleeve to prevent metal-to-metal contact and damage to pipe and coating during placement.

Hold-Down Method in Casing Pipe.

Water mains, force mains, and pressure sewer mains: Concrete invert and hold-down assembly or casing spacers following standard details and drawings.

Unless shown otherwise on the drawings, install ductile iron and PVC water pipes following Standard Details.

Bulkheads: As required.

-- End of Section --

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PIPE BURSTING

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SECTION 33 05 23.33

PIPE BURSTING

PART 1 GENERAL

1.1 DEFINITIONS

Burst Head: Conical shaped portion of Burst Tooling used to expand fractured pipe and surrounding soil to accommodate Product Pipe.

Burst Pit: Excavation where Static Pull Pipe Bursting Machine is located. The Product Pipe is pulled toward this pit.

Burst Tooling: Tooling designed to crack the Host Pipe, expand the remains of the Host Pipe and surrounding soil to allow passage of the Product Pipe.

Host Pipe: Existing pipe buried in the ground that will be rehabilitated by bursting (cracking) and pulling in a new replacement pipe (Product Pipe).

Insertion Pit: Excavation where Product Pipe enters the Host Pipe and bursting begins. Product Pipe is pulled through the Insertion Pit towards the Burst Pit.

Product Pipe: Newly installed pressure pipe made from high density polyethylene (HDPE).

Rod String: Assembled string of rods that extend from Burst Pit to Insertion Pit and serve to transmit tensile pullback forces to Burst Tooling.

Utility Crossing Pit: An excavation created at any point where another buried utility crosses the host pipe.

Rod Payout: Rod payout is the process of assembling a string of rods and pushing them in a stepwise manner from Burst Pit through the interior of the Host Pipe to Insertion Pit.

1.2 SCOPE OF WORK

Provide all labor, materials, equipment, supplies, and incidentals required to provide for the complete rehabilitation/replacement of deteriorated pipe by using a pipe bursting system at the locations shown on the drawings. Pipe bursting is a process by which the bursting unit splits and/or fractures the existing pipe while simultaneously installing a new HDPE pipe of the same or larger size into the annulus created by the forward movement of the bursting tool.

1.3 RELATED WORK

Other related or references sections contained herein are as listed below:

Section 01 33 00	SUBMITTAL PROCEDURES
Section 01 57 20.00 10	ENVIRONMENTAL PROTECTION
Section 31 00 00	EARTHWORK
Section 33 30 00	SANITARY SEWERS

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASSE A10.16	(1995; R 2001) Safety Requirements for Tunnels, Shafts, and Caissons
ANSI/AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service

ASTM INTERNATIONAL (ASTM)

ASTM A 242/A 242M	(2004; R 2009) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pipe Bursting Plan; G

SD-06 Test Reports

DVDs of television inspection; G

SD-07 Certificates

Qualifications of the Trenchless Installation Contractor; G

1.6 DRAWINGS

The drawings provided by the Contracting Officer shall be marked by the Contractor to show actual locations of valves, fittings, and other reconnects. These redline drawings shall be done the day of the actual placement.

1.7 QUALIFICATIONS

Certificates of training by the pipe bursting systems manufacturer stating that the operators have been fully trained in the use of the pipe bursting equipment by an authorized representative of the equipment manufacturer.

Qualifications of the Trenchless Installation Contractor:

Name, business, address, and telephone number of the Contractor.

Experience in successfully constructing pipelines by the method proposed to install the trenchless pipe for this project.

List of similar projects undertaken during the last 2 years including the name of a contact person and telephone number.

Certification as specified above.

Name(s) of all supervisory personnel to be directly involved with the project.

The Contractor shall sign and date the information provided and certify that to the extent of his knowledge, the information is true and accurate, and that the supervisory personnel for the trenchless installation operation will be directly involved with this project. Substitutions of personnel and/or methods will not be allowed without the written authorization of the Contracting Officer.

The Contractor shall be licensed in the State of Florida as a Certified Underground Utility Contractor.

The Contractor shall hold the Contracting Officer and Engineering Firm harmless in any legal action as a result of patent infringements.

1.8 REGULATORY REQUIREMENTS

Work in strict accordance with all Federal, State, and local ordinances, codes, statutes, rules, regulations, and requirements. Work shall comply with applicable criteria of ANSI/ASSE A10.16.

1.9 PIPE BURSTING PLAN

Submit a Pipe Bursting Plan to the Contracting Officer on a marked up copy of the drawings showing the construction phasing and plans for the proposed methods of pipe bursting installation. Plan details shall include:

a. Detail drawings and written description of the entire construction procedure to install pipe, bypass sewage flow and reconnection of sewer service connections, and force main connections to manholes, wetwells, and existing pressurized sewer pipe.

b. Pit locations for pipe insertion and burst machine location.

c. Location of utility crossing pits.

d. Schedule of when various sections are to be rehabilitated.

e. Distances of each pull.

f. Isolating points used to seal the system during the pipe burst.

g. Bypass plan and details.

h. Contact information for an on-call restoration/clean-up company able to respond to a sewage backup within 12 hours.

1.10 DELIVERY, STORAGE, AND HANDLING

Unload and handle materials with equipment of adequate capacity.

Store materials onsite in a reasonably level well-drained area free from brush.

Store individual pieces and bundles with safe walking space between to allow full view for inspection.

Transport, handle, and store pipe, fittings, and other products as recommended by the manufacturer.

1.11 PROJECT CONDITIONS

In the event that during the execution of the work any existing utility is broken causing the disruption of service or an eminent hazard, it shall be the responsibility of the Contractor to immediately notify the Contracting Officer at the designated emergency telephone number and immediately undertake measures to repair the damaged utility at the Contractor's cost. Before starting work, ascertain that the necessary repair parts, tools, equipment, and labor are ready and available onsite to complete the repair work without delays. The Contracting Officer shall witness the repair work.

Settlement or heaving of the ground surface during of after construction is not allowed. The Contractor is solely responsible for the repair to all areas damaged by such occurrences including but not limited to manmade structures such as buildings, roads, utilities, and landscaping damaged during the execution of the work.

Video inspections of all buildings under which pipe bursting is executed shall be performed by the Contractor before and after bursting installation. Building video inspections shall include the following:

a. Preconstruction DVDs of the interior and exterior of the building documenting the existing conditions before pipe bursting activities shall be submitted to the Contracting Officer for approval before pipe bursting under the building begins.

b. Postconstruction DVDs of the interior and exterior of the building documenting the condition after the pipe bursting activities shall be submitted to the Contracting Officer for approval before final invoice.

c. DVDs to remain property of the Contracting Officer; Contractor to retain second copy.

d. Should any portion of the inspection DVDs be of inadequate quality or coverage as determined by the Contracting Officer, the Contractor will have the portion reinspected and provide DVDs at no additional expense to the Government.

The Contractor is solely responsible for quality assurance during the length of the project. The Contractor shall be responsible for any costs associated with corrective measures required to replace or repair items not meeting the quality standards specified by the Contracting Officer.

1.12 ADDITIONAL CRITERIA FOR WORK ADJACENT TO RAILROADS

Do not schedule work within 15 feet of a railroad until the Contracting

Officer and the Government approve submittals. Approval does not relieve the Contractor of responsibility for adequacy and safety of procedures.

Place safety, precautionary, and protective devices and services required by OSHA and other local regulations before work begins.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Product Pipe

Provide high-density polyethylene (HDPE) pipe as specified in 33 30 00 SANITARY SEWERS.

2.1.2 Fittings

Provide HDPE fittings as specified in Section 33 30 00 SANITARY SEWERS.

PART 3 EXECUTION

3.1 GENERAL

The pipe bursting operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process are common. These changes are made to accommodate non-standard conditions. The Contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor. If the Contractor deems it necessary to deviate from the execution outline in this specification, then the Contractor shall notify the Contracting Officer immediately and present the proposed execution method changes for approval by the Contracting Officer.

Notify the Contracting Officer immediately if obstructions stopping forward motion of operation are encountered during installation.

Locate equipment used to perform the work away from buildings to lessen the noise impact. Provide silencers or other devices to reduce machine noise as required to meet the contract requirements.

Install all pulleys, rollers, bumpers, alignment control devices, and other equipment required to protect existing manholes and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Do not stress the product pipe under any circumstances beyond its yield stress.

3.1.1 Dewatering

Refer to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.2 PREPARATION

Refer to Section 01 57 20.00 10 and Volume 3, Drawing EN2 for requirements when working in sites with potential contamination and environmental issues.

3.2.1 By-Pass Pumping

The Contractor must maintain flow of the existing sewer system at all times. The Contractor shall provide diversion for the pipe bursting/replacement process. Provide pumps, wastewater storage, and by-pass lines of adequate capacity and size to handle all flows. All costs for by-pass pumping, wastewater storage, and wastewater disposal required during installation of the pipe shall be subsidiary to the pipe reconstruction item.

The Contractor is responsible for verifying LS capacities and for continuity of sanitary sewer service to each facility connected to the section of sewer during the execution of the work.

If sewage backup occurs and enters buildings, clean-up, repair, property damage cost, and claims are the responsibility of the Contractor.

3.3 INSTALLATION

The pipe bursting of force mains using HDPE product pipe will follow the method outlined below for each section of host pipe being rehabilitated. Perform these processes in series or in parallel with other sections of host pipe within the job; however each section will require these steps. The product pipe shall be free from defects before and after installation.

a. Excavate a Burst Pit at one end of the section down to pipe grade for placement of the pipe bursting equipment.

b. Excavate an Insertion Pit at the opposite end of the section down to grade for entry of the Product Pipe.

c. Excavate utility crossing pits.

d. Isolate the section to be rehabilitated from the rest of the system to maintain the pressure and flow of the system. Start bypass system.

e. Cut host pipe.

f. Excavate and remove valve tees from the Host Pipe.

g. Assemble Rod String as it is thrust through the Host Pipe from Burst Pit to Insertion Pit.

h. Attach Burst Tooling and Product Pipe to rod end at the insertion pit.

i. Pull back Rod String and disassemble simultaneously while tooling and Product Pipe travel from Insertion Pit to Burst Pit.

j. Perform hydrostatic test of the Product Pipe section in accordance with Section 33 30 00 SANITARY SEWERS.

k. Connect the replaced section of pipe into the system. Stop bypass system.

l. Visually inspect for leaks at new connections.

3.3.1 Pit Location and Excavation

Place Burst Pit and Insertion Pit locations such that excavations are minimized.

Burst length shall be 400 feet, plus/minus 50 feet, in length for first two bursts. After soil pipe friction is evaluated longer burst runs may be performed.

Shore all pits to ensure worker safety in accordance with OSHA and other local regulations.

Rope off and cover all pits when not active in accordance with OSHA or local regulations to ensure public safety. Keep to a minimum the duration that pits are open.

Traffic control shall be accommodated for in accordance with the contract requirements. Ensure that safe traffic passage around pit excavations that are located in or adjacent to streets or highways is in accordance with Government requirements. Ensure that congestion and traffic delays are minimized due to parking of related employee vehicles, trucks, and auxiliary equipment.

Expose utilities crossing the Host Pipe using an excavation technique appropriate for the utility. The Utility Crossing Pit shall exist before starting bursting. Man-entry shoring is not required; however provide appropriate safety precautions.

Keep pits as dry as possible and excavate to at least 1 foot below the pipe invert to minimize the potential for contamination during connection of the new main, valves, and fittings.

3.3.2 Bursting Machine Location and Shoring

Shore Burst Pit in accordance with OSHA and other local regulations.

Maintain perpendicular burst machine alignment to the pipe during pullback.

Provide rearward shoring or anchoring to react to rod thrust forces during payout. While these forces are substantially lower than pullback forces, use shoring to stabilize the bursting machine to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react to thrust forces. Only use the Host Pipe at the rear face of the pit for rearward shoring if it is scheduled for replacement.

Cut off pipe face for cast iron, ductile iron, or PVC using a saw or similar device to produce a square face for the bursting machine's forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Remove host pipe in sufficient length to accommodate burst machine.

Position burst machine to have rod centerline at approximate centerline of Host Pipe.

Accommodate for rod box delivery and removal between temporary rod storage location and burst pipe with appropriate lifting equipment and techniques. Additionally, include movement and/or placement of lifting machine in traffic control plans.

3.3.3 Rod Payout Operation

Count rods during payout or quantity of rods per box so that the operator is aware of the distance between the burst machine and the lead end of the Rod String.

Thrust force shall be monitored by the operator. Should an unexpected sudden increase in thrust force be experienced, halt the process. The operator or Contractor shall:

a. Locate the front end of the Rod String by its distance from the Burst Pit. Paint and compare the location with the asbuilt drawings.

b. Take appropriate action to remedy the cause. This may include an additional pit at the obstruction to determine the cause and remove or accommodate for the obstruction.

Cut the Host Pipe in the Insertion Pit before the arrival of the Rod String. Remove sufficient length to allow the Burst Tooling to enter the Host Pipe and bend the product pipe within the allowable radius specified by the pipe manufacturer. Position or work the second end of the Host Pipe in the Insertion Pit so that the Product Pipe is not damaged as it travels through the Insertion Pit.

Do not enter the Insertion Pit when the Rod String is nearing the pit. A worker shall be in visual or radio contact with the burst machine operator so that the payout is halted in a position that allows attachment of the Burst Tooling.

3.3.4 Tooling and Attachment

Move the Product Pipe into position for attachment to the Rod String. Exercise appropriate traffic or pedestrian control along the path of the Product Pipe.

Paint the lead and second rod orange or yellow to give notice to the burst machine operator position of the Burst Tooling.

Attachment of the Burst Tooling to the rod shall be through the use of a removable pin joint allowing the tooling to pivot at least 46 degrees to the rod axis.

Choose Burst Tooling style based on anticipated properties of Host Pipe and Host Pipe repairs as recommended by burst tooling manufacturer.

Ensure that the Burst Head diameter is a minimum of 15 percent over size to the outside diameter of the Product Pipe.

Attach the Product Pipe to the Burst Tooling with a swivel that permits rotation to relieve torsional (twist) stress on the Product Pipe.

The Burst Head shall slide on the Rod String so that the rear of the Burst Head overlaps the forward end of the Product Pipe to eliminate the chance of damage to the Product Pipe. If soil flows into product pipe, then the product pipe shall be temporarily plugged, covered, or sealed during installation to prevent soil from filling the pipe.

3.3.5 Pullback Operation

Before starting pullback, there will be visual or radio contact between observers stationed adjacent to the Insertion Pit, the burst machine operator, and a Product Pipe observer stationed strategically along the length of the Product Pipe to watch for Product Pipe entanglement with aboveground obstructions.

The Insertion Pit observer will signal the burst machine operator to begin the pullback. Progress slowly until the observer sees the Burst Tooling has completely entered the Host Pipe.

Monitor pipe progress for the first 20 feet of pullback by the Insertion Pit observer and the Product Pipe observer.

As the Burst Tooling nears any Utility Crossing Pit, an observer in radio or visual contact with the burst machine operator will monitor and control movement of the Burst Tooling past the utility.

Existing bends less than or equal to 45 degrees may be burst through without installation of a replacement fitting if the resulting bend in the replacement pipe does not exceed the manufacturer's allowable bend radius. If the Contractor cannot maintain the allowable bend radius, then the fitting shall be removed and a new HDPE fitting of like size shall be installed.

3.3.6 Tooling Removal

Burst machine operator shall note rod count and anticipate entry of painted rods into the Burst Pit. As the pin joint connection nears the burst machine forward face, halt the burst. Relieve the load on the forward face by reversing the rod direction slightly.

Disassemble and remove the tooling string, in sections if necessary, until the Product Pipe face has been pulled beyond the face of the Burst Pit. The distance past the forward face of the Burst Pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.

3.3.7 Sealing Manholes

Connect replacement pipe to existing manholes as specified in Section 33 30 00 SANITARY SEWERS.

3.3.8 Sealing Wetwells

Connect replacement pipe to existing wetwells as detailed in Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

3.3.9 Connection to Existing Force Mains

Use DI/HDPE mechanical joint adaptors or transition fittings to connect to existing buried force main as specified in Section 33 30 00 SANITARY SEWERS.

Connections to existing force main shall be mechanical joint transition couplings or sleeves.

a. Mechanical joint fittings used with PVC pipe (3-inch- through 36-inch-diameter DR 18 pipe) shall be restrained with the EBAA Iron Megalug Series 2000 PV retainer or an equal approved by the Contracting Officer. The Series 200 PV retainers shall provide a minimum of 150-psi restraint with a 2 to 1 safety factor. The restraining device and Tee head bolts shall be manufactured of high-strength ductile iron meeting ASTM A 536, Grade 65-42-10. Clamping bolts and nuts shall be manufactured of corrosion-resistant, high-strength, low-alloy Cor-Ten steel meeting the requirements of ASTM A 242/A 242M.

b. Provide retainer glands for all buried DI mechanical joints, fittings, and DI pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

1. Gland: Manufactured of DI conforming to ASTM A 536. Gland dimensions shall match ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53.

2. Restraining Devices: Manufactured of DI heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.

3. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.

4. Acceptable manufacturers: EBAA Iron, Inc. - Megalug 1100 Series, or approved equal.

3.3.10 Backfill and Surface Restoration

Backfilling and surface restoration shall be in accordance with Section 31 00 00 EARTHWORKS.

3.4 TESTING

Conduct hydrostatic testing as specified in Section 33 30 00 SANITARY SEWERS.

After the existing sewer is completely replaced, conduct internal inspection with television camera and videotape. Ensure that the finished installation is free of visual defects.

Repair defects or replace pipe which may affect the integrity or strength of the pipe in the opinion of the Contracting Officer. Repair or replacement is at the Contractor's expense.

Television inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit color television.

Television inspection shall include the following:

a. Submit post-construction DVDs to the Contracting Officer before final invoice.

b. DVDs to remain property of the Contracting Officer; Contractor to retain second copy.

c. Post-construction DVD upon completion of reconstruction of sewer with voice description and stationing of services indicated. Data and stationing to be on screen on DVDs.

d. Should any portion of the inspection DVDs be of inadequate quality or coverage as determined by the Contracting Officer, the Contractor will have the portion reinspected and provide DVDs at no additional expense to the Government.

-- End of Section --

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DIVISION 33 - UTILITIES

SECTION 33 05 24

DIRECTIONAL DRILLING

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SECTION 33 05 24

DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SCOPE OF WORK

This Section includes furnishing all labor, materials, equipment, and incidentals necessary to complete each directional drill (or horizontal directional drilling, HDD) installation shown on the drawings.

Directional drilling at additional locations must receive prior approval from the Contracting Officer.

1.2 RELATED WORK

Section 01 33 00	SUBMITTAL PROCEDURES
Section 01 57 20.00 10	ENVIRONMENTAL PROTECTION
Section 31 00 00	EARTHWORK
Section 33 11 00	WATER DISTRIBUTION

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 13A	(2006; Errata 2008) Specification for Drilling-Fluid Materials

ASTM INTERNATIONAL (ASTM)

ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM D 1248	(2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 149	(2009) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 3261	(2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3350	(2010) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 4976	(2006) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D 790	(2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bore Plan; G

Submit an electronic copy and three hard copies of the record drawings (G) to the Contracting Officer within 5 days after completing the pull back. The record drawings shall include a plan, profile, and all information recorded during the progress of the work. The record drawings shall be tied to the project's survey control.

SD-03 Product Data

Directional Drilling Equipment
Size, capacity, and arrangement of equipment
Location and size of drilling and receiving pits
Dewatering and methods of removing spoils material
Type, location, and method of installing locator station
Method of fusing pipe segment and type of equipment
Type of cutting head
Method of monitoring and controlling line and grade
Method of detecting surface movement

SD-07 Certificates

Contractor's State License Number; G

Submit statement of qualifications and records of previous similar jobs; G

1.5 GENERAL REQUIREMENTS

ASTM A 48/A 48M--(2003; R 2008) Standard Specification for Gray Iron Castings

ASTM A 307--(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM D 3261--(2003) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3350--(2008) Polyethylene Plastics Pipe and Fittings Materials

ASTM D 4976--(2006) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

ASTM F 714--(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

1.6 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Store materials onsite in enclosures or under protective covering. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects shall be rejected and removed from the job site.

Disposal of fluids is the responsibility of the Contractor. Disposal of fluids shall be done in a manner that is in compliance with all permits and applicable federal, state, and local regulations. The Contractor may dispose of the drilling fluids on approved land owned by the Government. The drilling slurry shall be spread over the Government-approved disposal area and plowed into the soil.

1.6.1 Handling

Handle conduit, piping, fittings, and other accessories in a manner to ensure delivery to the excavation in sound, undamaged condition. Carry, do not drag, conduit/piping to the excavation. Store conduit, piping, and fittings that are not to be installed immediately, under cover out of direct sunlight.

1.7 QUALIFICATIONS

The Contractor to perform this work is to be a State Licensed Underground Utilities Contractor.

The Contractor and his field supervisor assigned to this project must be experienced in work of this nature and must have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last 3 years. The Contractor shall submit a description of such project(s) which shall include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type and size installed, length of installation, type and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.8 SAFETY

Directional drilling equipment machine safety requirements shall include common grounding system to prevent electrical shock in the event of underground electrical cable strike. The grounding system shall connect all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. The drill shall be equipped with an "electrical strike" audible and visual warning system that will notify the system operators of an electrical strike.

Provide equipment to guard against electrocution and an alarm system on drilling equipment capable of detecting electrical current as it approaches electric lines

1.9 BORE PLAN

Prior to beginning work, the Contractor must submit to the Contracting Officer a to-scale shop drawing of the pilot bore plan with vertical scale 1-inch equals 2 inches and horizontal scale 1-inch equals 20 feet. The plan shall show finished grade, deflection and radii of the pilot bore, and all existing utilities with minimum vertical and horizontal clearances. The proposed clearance shall exceed the guidance system accuracy tolerance by a minimum of 100 percent.

PART 2 PRODUCTS

2.1 DRILL ROD

The Contractor shall select the appropriate drill rod to be used. The drill rod shall be inspected and approved for use by the Contractor prior to arrival at the work site.

2.2 DIRECTIONAL DRILLING EQUIPMENT REQUIREMENTS

The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back of the pipe, drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the system. All equipment shall be in good, safe condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of this project.

2.2.1 Drilling Rig

The directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. The hydraulic system shall be free of leaks. The rig shall have a system to monitor and record maximum pullback pressure during the pullback operations. There shall be a system to detect electrical current from the drill string and an audible alarm that automatically sounds when an electrical current is detected.

2.2.2 Drill Head

The drill head shall be seeable by changing its rotation, and shall provide necessary cutting surfaces and drilling fluid jets.

2.2.3 Mud Motors (If Required)

Mud motors shall be of adequate power to turn the required drilling tools.

2.3 LOCATING EQUIPMENT

Shall have manufacturer tolerances of plus/minus 0.25 foot or better. Equipment shall be calibrated prior to the beginning of the work. Rods and pipe shall be located during the drilling process, to the tolerance in the contract documents.

2.4 PRODUCT PIPE

2.4.1 HDPE Piping for Potable Water

The product pipe to be installed shall be HDPE as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2 HDPE Piping for Electrical

2.4.2.1 Polyethylene, Flexible Conduit

ASTM D 1248. Provide conduit that is continuous, flexible, high-density polyethylene Type III, SDR 11, IPS pipe of the size indicated on the drawings.

2.4.2.2 Transitions, HDPE to PVC

Install transitions for bonding high-density polyethylene conduit Type III, SDR 11 pipe to Schedule 40 PVC conduit using a two-part resin conduit adhesive specifically designed for the purpose and consisting of the following minimum properties:

Hardness (Shore D Durometer) 70-80
Flexibility (ASTM D 790) >2 percent
Dielectric Strength (ASTM D 149) 450 Volts/Mil (Nonconductive)
Air-tight (no leakage) 120 psi
Typical Adhesive Shear Strength: Substrate (HDPE to PVC 275 lbs/in2)
Typical Impact Resistance: HDPE 24.8 in-lbs, PVC 37.2 in-lbs

Bevel the inner diameter of the HDPE to create a smooth passage for cable pulling. Terminate the HDPE conduit in the belled end of the PVC conduit. Apply adhesive in accordance with the approved manufacturer's installation instructions.

2.5 DUCTILE IRON PIPE FOR HDD

Ductile iron piping for HDD shall be as specified in Section 33 11 00 WATER DISTRIBUTION.

2.6 DRILLING FLUIDS

Refer to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and Volume 1, Drawing EN2 for requirements when working in sites with potential contamination and environmental issues. Put in place additional environmental protection necessary to contain any hydraulic or drilling fluid spills, including berms, liners, turbidity curtains, and other measures. Do not store fuel in bulk containers within 200 feet of any water body or wetland area.

Provide a self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid. The mixing system shall continually agitate the drilling fluid during operations.

Use a high quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Ensure that the composition of the fluid complies with API Spec 13A.

Mix the bentonite drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. The Contractor is responsible for any required pH adjustments. Provide bentonite product that contains the proper additives according to the manufacturer for use in directional drilling in the soil conditions that are expected to be encountered on the project.

The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm at least 12 inches high shall be maintained around drill rigs, the drilling fluid mixing system, entry and exit pits, and the drilling fluid cycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities. The Contractor shall be responsible for properly disposing of any waste product generated as part of this operation.

The drilling fluid recycling system shall separate sand, dirt, and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

2.7 WIRE TRACING

For nonmetallic piping, provide tracing wire in accordance with Section 31 00 00 EARTHWORK. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

2.8 GUIDANCE SYSTEMS

A Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to 50 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate and calibrated to the manufacturer's specifications of the vertical depth of the borehole at the sensing position at depths of up to 50 feet and accurate to 2 feet horizontally.

Components: The Contractor shall supply all components and materials to install, operate, and maintain the guidance system.

The guidance system shall be of proven type, and shall be set up and operated by personnel trained and experienced with the system. The operator shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

PART 3 EXECUTION

3.1 DRILL SET-UP AREA

Contractor may not disturb existing fence, structure, walkways, drive isles, and business operations during directional drilling operations.

3.2 DRILL ENTRANCE AND EXIT PITS

Contractor shall be responsible for design and construction of the drill entrance and exit pits.

Drill entrance and exit pits are required and shall be maintained at a minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or a processing system or removal from the site.

Drilling mud shall not be allowed to flow freely on the site or around the entrance or exit pits. Mud spilled shall be removed as soon as possible and the ground restored to original condition. Pits shall be shored to OSHA standards.

When drilling near wetlands or water courses, the Contractor shall provide secondary containment to prevent drilling fluids from entering the wetlands area or water course by using sandbags or other acceptable means as approved by the Contracting Officer.

3.3 DRILL ENTRANCE AND EXIT ANGLE

Entrance and exit angles can be whatever the Contractor desires such that the elevation profile maintains adequate cover to reduce the risk of drilling fluid breakouts and that ground exit occurs as specified herein.

Contractor shall be responsible for ensuring that entrance and exit angles ensure pullback forces do not exceed 5 percent strain on the polyethylene pipe.

3.4 DRILLING FLUIDS

Maintain drilling fluid in the bore hole to increase the stability of the surrounding soil and reduce drag on the pulled pipe.

Dispose of the drilling fluids in compliance with all relative environmental regulations, right-of-way and work space agreements, and permit requirements.

Drilling fluid returns can be collected in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

Provide drilling fluid relief holes as required to prevent heaving of earth, pavement, or roads. Properly seal the relief holes in a timely manner to prevent any damage or injury.

Minimize drilling fluid at locations other than entry and exit points.

Immediately clean up any drilling fluids that inadvertently surface.

3.5 PILOT HOLE

The type and size of the pilot string cutting head and the diameter of the drill pipe shall be at the Contractor's discretion.

The pilot hole shall be drilled along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:

1. Horizontal tolerance: 1-1/2 feet from the centerline of the product pipe.

2. Entry Point Location: The pilot hole entry point shall be within plus or minus 3 feet of the location shown on the drawings or as directed by the Contracting Officer in the field.

3. Exit Point Location: The exit point location shall be within plus or minus 3 feet of the location shown on the drawings or as directed by the Contracting Officer in the field.

The installed pipeline cover requirements as shown on the drawings or as specified shall not be violated.

At completion of pilot hole drilling, furnish Contracting Officer with tabulations of horizontal and vertical alignment.

3.6 REAMING

Reaming operations shall be conducted at the Contractor's discretion. The type of back reamer to be utilized shall be determined by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type shall be at the Contractor's discretion.

3.7 PULLBACK

The entire pipeline to be installed via directional drill shall be fully assembled prior to commencement of pullback operations.

The pipeline shall be supported during pullback operations in a manner to enable it to move freely and prevent damage. The pipeline shall be installed in one continuous pull.

Torsional stress shall be minimized by using a swivel to connect the pull section to the reaming assembly.

The maximum allowable tensile force imposed on the pull section shall not exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe sizes or materials, the lowest safe pull strength value shall govern and the maximum allowable tensile force shall not exceed 90 percent of this value.

External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the Government. Buoyancy modification shall be at the discretion of the Contractor.

Pull detection wire along with HDPE pipe. Extend wire into closest valve box at each end of HDPE pipe.

3.8 GUIDANCE SYSTEMS

Use a magnetic survey tool located behind the pilot string cutting head.

3.9 CLEANING CONDUIT PIPE

Thoroughly clean out each conduit run as it is completed by drawing a stiff bristle brush, of the nominal conduit size, through until conduit is clear of particles of earth, sand, gravel, and water. Swab the conduits with a poly-pig of the nominal conduit size and test the conduit with a non-flexible testing mandrel no less than 7 inches in length with a diameter suitable for the conduit being cleaned. After cleaning immediately install conduit caps. Provide mule tape in each conduit with minimum 8900 newton pulling strength. Mandrel shall be approved by the Contracting Officer before use. A tag line is required on each end of the mandrel during the testing process. Provide a tag line of sufficient strength to withdraw the cleaning device.

3.10 DOCUMENTATION

The Contractor shall maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 15 feet along the drill path. In addition, logs shall be kept that record, as a minimum, the following every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

1. Drilling fluid pressure.
2. Drilling fluid flow rate.
3. Drill thrust pressure.
4. Drill pullback pressure.
5. Drill head torque.

The Contracting Officer or Contracting Officer's Representative shall have access to instrumentation, readings, and logs at all times during operation.

3.11 UTILITY LOCATES

Contractor shall locate all utilities prior to the start of excavation or drilling. The Contractor shall be responsible for damage to utilities and shall repair damaged utilities at no cost to the Government.

3.12 TESTING

See Section 33 11 00 WATER DISTRIBUTION for testing requirements.

3.13 CLEANUP

Immediately upon completion of work of this section all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat condition acceptable to the Contracting Officer.

"Blow holes" or "breakouts" of drilling fluid to the surface shall be cleaned up immediately and the surface area returned to its original condition. All drilling fluids, spoils, and separated materials shall be disposed of in compliance with federal, state, and local environmental regulations.

-- End of Section --

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DIVISION 33 - UTILITIES

SECTION 33 11 00

WATER DISTRIBUTION

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SECTION 33 11 00

WATER DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI C1012	(2007; Errata 2009) Ductile Iron or Malleable Iron for 1/2-inch thru 1-1/2-inch

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A21.11	(2000) Rubber Gasket Joints Cast and Ductile Iron Press Pip
ANSI A21.53	(2006) AWWA Standard for Ductile-Iron Compact Fittings for Water Service

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2005) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2002; Errata 2003) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
ANSI/AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C200	(2005) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C207	(2007) Standard for Steel Pipe Flanges for

	Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C220	(1998) Stainless Steel Pipe, 4 in. (100 mm) and Larger
AWWA C502	(2005) Dry-Barrel Fire Hydrants
AWWA C504	(2006; R 2010) Standard for Rubber-Seated Butterfly Valves
AWWA C509	(2009) Resilient-Seated Gate Valves for Water Supply Service
ANSI/AWWA C512	(2007) Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
ANSI/AWWA C515	(2009) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C800	(2005) Underground Service Line Valves and Fittings
AWWA C900	(2007; Errata 2008) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C901	(2008) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service
AWWA C906	(2007) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In., (1,575 mm) for Water Distribution and Transmission

AMERICAN WELDING SOCIETY (AWS)

AWS A5.4/A5.4M	(2006) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS A5.9/A5.9M	(2006; Errata 2007) Specification for Bare Stainless Steel Welding Electrodes and Rods

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.1	(2010) Power Piping
ASME B36.10	(2004; R 2010) Welded and Seamless Wrought Steel Pipe
ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Standard for Square and Hex Nuts
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2003; R 2008) Machine Screws and Machine Screw Nuts
ASME B31.3	(2010) Process Piping
ASME B36.19M	(2004; R 2010) Stainless Steel Pipe
ASME BPVC SEC VIII	(2007; Addenda 2008) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessels, Division 1
ASME SA-36/SA-36M	(2007) Carbon Structural Steel
ASME SA-675/SA-675M	(2007) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2010) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 182/A 182M	(2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 240/A 240M	(2011a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A 242/A 242M	(2004; R 2009) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 269	(2008) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A 27/A 27M	(2008) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2011) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A 325	(2009a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 380	(2006) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A 403/A 403M	(2010a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 489	(2004e1) Standard Specification for Carbon Steel Lifting Eyes
ASTM A 513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 53/A 53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 530/A 530M	(2004a; R 2010) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 575	(1996; R 2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 2006) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 582/A 582M	(2005) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A 635/A 635M	(2009b) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for
ASTM A 774/A 774M	(2006) Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A 813/A 813M	(2007) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A 90/A 90M	(2009) Standard Test Method for Weight {Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 32	(2008) Standard Specification for Solder Metal
ASTM B 584	(2009a) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B 62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 633	(2007) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B 68	(2002) Standard Specification for Seamless Copper Tube, Bright Annealed
ASTM B 75	(2002) Standard Specification for Seamless Copper Tube
ASTM B 763	(2008a) Standard Specification for Copper Alloy Sand Castings for Valve Application
ASTM B 88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B828	(2002; R 2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D 1330	(2004) Rubber Sheet Gaskets
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2009) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 3261	(2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic

	Pipe and Tubing
ASTM D 3350	(2010) Polyethylene Plastics Pipe and Fittings Materials
ASTM E 488	(1996; R 2003) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F 1554	(2007a) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F 2206	(2002; R 2010) Standard Practice for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
ASTM F 436	(2010) Standard Specification for Hardened Steel Washers
ASTM F 477	(2008) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 593	(2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 594	(2009) Standard Specification for Stainless Steel Nuts
ASTM F 656	(2010) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 879	(2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2008) EJMA Standards

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

FAC 62-555.335	(2003) Guidance Documents for Public Water Systems
FAC 62-555.340	(2003) Disinfection and Bacteriological Evaluation of Public Water System Components

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-60	(2004) Connecting Flange Joint between Tapping Sleeves and Tapping Valves
MSS SP-83	(2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2010) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2009) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2010a) Drinking Water System Components - Health Effects

PLASTICS PIPE INSTITUTE (PPI)

PPI TR-4	(2010) PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
PPI TR-33	(2006) Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

UNDERWRITERS LABORATORIES (UL)

UL 789	(2004; R 2008) Standard for Indicator Posts for Fire-Protection Service

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water main accessories, and gate valves as specified and where indicated.

Provide water distribution mains indicated as 6 through 16 inch diameter pipe sizes of ductile-iron pipe. Provide water distribution mains indicated as 2- through 4-inch diameter pipe sizes of polyvinyl chloride (PVC) plastic pipe. Also provide water main accessories, gate valves, and automated flushing valves as specified and where indicated.

1.2.2 Water Service Lines

Provide water service lines indicated as 1- and 2-inch lines from water distribution main to building service at the point indicated. Water service lines shall be polyvinyl chloride (PVC) plastic pipe. PVC plastic pipe appurtenances, and valves as specified for water mains may also be used for service lines. Provide water service line appurtenances as specified.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Water Line Connection Plan; G

As-Built Drawings; G

SD-03 Product Data

Pipe Connections; G

Ductile Iron Pipe; G

Retainer Glands; G

Water service line piping, fittings, joints, valves, and coupling; G

Ductile Iron Fittings; G

Valves; G

HDPE Pipe and Fittings; G

Appurtenances; G

Polyvinyl Chloride (PVC) Pressure Pipe; G

Fittings for PVC Pressure Pipe; G

Galvanized Steel Pipe; G

Stainless Steel Pipe and Fittings; G

Copper Tube and Fittings; G

Unions; G

Valve Boxes; G

Hydrants; G

Corporation; G

Automatic Flushing Unit; G

Service Saddles; G

Indicator Posts; G

Submit manufacturer's instructions or catalog cuts.

Pipe Insulation; G

Include insulation protective coverings, vapor barrier, adhesives, sealants, coatings, reinforcing mesh, and bands.

SD-05 Design Data

Axial Deflection Calculations

SD-06 Test Reports

Hydrostatic Test; G

Leakage Test; G

Bacteriological Disinfection; G

Test results from commercial laboratory verifying disinfection

HDPE Pipe and Fittings; G

Tapping Valves; G

1.4 SHOP DRAWINGS

A Water Line Connection Plan shall be submitted by the Contractor for the complete water system prior to start of work. The plan shall describe connections to existing water main, including any necessary valve closures and temporary outages.

As-built drawings are required for all systems and will be prepared by a surveyor registered in the State of Florida. As-built drawing shall contain the following information:

Location of valves, fittings, hydrants, and meters.

Elevation of top of water line at all utility crossings.

Separation between other utilities within 10 feet horizontally.

Material used.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials, and rubber gaskets under cover out of direct sunlight. Do not exceed the manufacturer's recommended stacking height during storage. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, and hydrants free of dirt and debris.

1.5.2 Handling

Handle pipe and accessories to ensure delivery to the trench in an undamaged conditions. Take particular care not to injure the pipe coating. When the coating or lining of any pipe or fitting is damaged, the Contractor shall repair at his expense in an approved manner. Do not place other pipe or material inside of a pipe or fitting after the coating has been applied. Carry the pipe into position. Only use pinch bars and tongs for aligning or turning the pipe on the bare ends of the pipe. Clean the interiors of pipe and accessories before the pipe or accessories are lowered into the trench keep clean during laying operations by an approved method. Before installation, inspect the pipe for defects. Replace material found to be defective before or after laying with sound material without additional cost to the Government. Store rubber gaskets that are not to be installed immediately in a cool dark place out of the direct rays of the sun.

1.5.3 Protective End Caps

The Contractor shall provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

PART 2 PRODUCTS

Ensure that newly installed or constructed public water system (PWS) components that come into contact with drinking water or drinking water treatment chemicals conform to NSF/ANSI 61 or Section 6 of NSF/ANSI 14.

Ensure that any pipe and pipe fitting used in the construction, alteration, or repair of any PWS is lead free (contains not more than 8 percent lead). Ensure that any plumbing fitting or fixture that is intended to dispense water for human consumption and that is used in the construction, alteration, or repair of any PWS is lead free (in compliance with Section 9 of NSF/ANSI 61 as adopted in FAC 62-555.335).

Color code or mark all water main pipes, including fittings, using blue as a predominant color to differentiate drinking water from reclaimed or other water. Apply blue stripes to the pipe wall of underground metal pipe. Ensure that pipe striped during manufacturing of the pipe has continuous stripes that run parallel to the axis of the pipe, are located at no greater than 90-degree intervals around the pipe, and will remain intact during and after installation of the pipe.If tape or paint is used to stripe pipe during installation of the pipe, apply the tape or paint in a continuous line that runs parallel to the axis of the pipe and that is located along the top of the pipe; for pipes with an internal diameter of 24 inches or greater, apply tape or paint in continuous lines along each side of the pipe as well as along the top of the pipe.

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

Ensure that all materials in contact with potable water are NSF/ANSI 61 approved and are suitable for use with chloraminated water.

2.1.1.1 Ductile-Iron Piping

All ductile-iron piping shall be cement-lined manufactured in accordance with AWWA C150/A21.50 and AWWA C151/A21.51 for the following minimum operating conditions:

Pressure Class: All ductile-iron piping shall meet the following minimum working pressure classes:

(a) 4-inch through 12-inch: 350 psi
(b) Pipe greater than 12 inches: 250 psi.

Provide buried pipe and fittings that are petroleum asphalt coated according to the manufacturer's recommendations and encased in 8-mil high-density polyethylene tubes in accordance with AWWA C105/A21.5 Method A. Paint all flanged and above-grade or exposed pipe and fittings in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

Where new flanged pipe is joined with existing and other new flanges, provide adaptor flange pipe sections if necessary.

Ensure that all bolts, nuts, and stud provided are corrosion-resistant alloy with hex heads or heavy hex heads conforming to AWWA C115/A21.15 and Appendix A of AWWA C115/A21.15, except where otherwise indicated on the drawings.

2.1.1.1.1 Ductile-Iron Joints

Ductile-iron fittings below grade/buried shall be furnished with mechanical joints and ductile-iron fittings above grade/exposed shall be furnished with flanged joint ends as shown on the drawings and specified in this Section

Mechanical Joints: All buried ductile-iron fittings shall be furnished with mechanical joint ends unless noted otherwise. Mechanical joints shall conform to AWWA C111/A21.11. Glands shall be constructed of ductile-iron.

Flanged Joints: Pipe for threaded flange fabrication shall be Special Thickness Class 53 in accordance with AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C115/A21.15. Bolt circle and bolt holes shall match those of ASME B16.1 Class 125 flanges. The flanges shall be rated for a maximum working pressure of 250 psi. Threaded flanges shall be individually fitted and machine tightened on the pipe ends. Flange facing shall be smooth or with shallow serrations in accordance with AWWA C115/A21.15.

2.1.1.1.2 Ductile-Iron Fittings

General: Ductile iron pipe fittings shall be the compact type meeting the requirements of AWWA C111/A21.11, AWWA C110/A21.10, and be cement lined and seal coated. Fittings shall be manufactured in accordance with AWWA C110/A21.10. Where taps are 1/8-inch thick full-face-type and conform to the dimensions of Appendix A of AWWA C115/A21.15 shown on fittings, tapping bosses shall be provided. At a minimum, fittings shall have the same pressure rating as the connecting pipe.

Flanged Joint: AWWA C110/A21.10 and ASME B16.1, faced and drilled 125-pound ANSI standard.

Mechanical Joint: AWWA C110/A21.10.

Provide mechanical joint fittings for all buried fittings as shown in the drawings, unless noted otherwise.

Provide specified gaskets.

2.1.1.1.3 Lining and Coating

Perform all field measurements confirming the accuracy of the piping sizes and lengths shown on the drawings. Notify the Contracting Officer immediately before deviating from or altering the lining of ductile iron piping shown on the approved layout schedule.

Cement-Lined Ductile Iron Pipe and Fittings: Interior surfaces of all cement-lined ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with a standard thickness cement-mortar lining applied in conformity with AWWA C104/A21.4, Portland cement mortar. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, repair or replace damaged or unsatisfactory portions with lining conforming to these Specifications at no additional cost to the Government. Pipe linings for potable water lines shall be NSF/ANSI 61 approved.

All ductile iron pipe and fittings cement-mortar linings shall be surface sealed with an asphaltic seal coating, 1 mil, in accordance with AWWA C104/A21.4.

Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 90 00.00 98 PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 90 00.00 98 PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

2.1.1.1.4 Manufacturers

Acceptable ductile iron pipe manufacturers include US Pipe, American Ductile Pipe, Griffin Pipe, or approved equal.

2.1.1.1.5 Gaskets

Gaskets shall be EPDM, Viton, or an approved equal. Wherever contaminated groundwater or contaminated soils are present, gaskets shall be Viton, or an approved equal. Refer to drawings for locations.

Gaskets for mechanical joints shall be compatible with potable water pipe service and be in accordance with ANSI A21.11 and ASTM D 1330.

Flange gaskets shall be in accordance with AWWA C207, except as modified in this Section. Gaskets shall be ring type. All gasket material shall be suitable for potable water and shall be resistant to free chlorine concentrations up to 10 mg/L. All gasket material shall be rated to the surge pressures noted under the paragraph entitled "Ductile-Iron Piping" of this Section.

Gaskets for flanged joints shall be 1/8-inch-thick, cloth-inserted rubber conforming to applicable parts of ASME B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients. Gaskets shall be full-face type for 125-pound flanges.

2.1.1.1.6 Retainer Glands

Retainer glands shall be provided for all buried ductile-iron mechanical joints, fittings, and ductile-iron pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

a. Gland: Manufactured of ductile iron conforming to ASTM A536. Gland dimensions shall match ANSI A21.11 and ANSI A21.53.

b. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.

c. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.

d. Acceptable Manufacturers are EBAA Iron, Inc. - Megalug 1100 Series, or approved equal.

2.1.1.1.7 External Pipe Restraints

Ductile-iron pipe push-on (bell and spigot) joint restraint shall be provided by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile-iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Torque limiting twist-off nuts shall be provided on each wedge to ensure proper applied installation torque. The split ring shall be made from 60-42-12 ductile-iron conforming to ASTM A 536. The connecting rods shall be made of steel conforming to AWWA C111/A21.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have 350-psi maximum working pressure rating and 18- to 36-inch-diameter restraining harnesses shall have 250-psi maximum working pressure rating. All harnesses shall be designed with a 2-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers are EBAA Iron, Inc. - Series 1700 or approved equal.

2.1.1.1.8 Internal Pipe Restraint

Acceptable manufacturers are:

American Ductile Iron Pipe:

Fast Grip® Gasket
Flex Ring® Joint

US Pipe:

Field Lok® Gasket
TR Flex Restrained Joint Pipe and Fittings

or Contracting Officer-approved equal.

2.1.1.2 Pipe Connections

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

13. Cast-in Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

    a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized in accordance with ASTM A 153/A 153M.

14. Expansion Anchors: Anchor bolt and sleeve assembly with the ability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed

when installed in concrete, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

b. Material for Anchors in Exterior Locations: Alloy Group (A4) stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.1.1.3 Polyvinyl Chloride (PVC) Pressure Pipe

2.1.1.3.1 4-Inch PVC Pressure Pipe

Unless otherwise noted, ensure that PVC pressure pipe for nominal diameters 4 inches conforms to the requirements of AWWA C900 DR 18 with gasketed integral bell ends. Ensure that pipe is designed for maximum working pressure of not less than 150 psi. Ensure that the pipe is made to ductile iron pipe ODs instead of IPS. Ensure that the PVC pipe is NSF approved for potable water use.

The following pipe joints and fittings restraint methods can be used to prevent pipe joints and fittings from separating under pressure. No additional financial compensation will be provided to the Contractor for providing the following methods of restraint:

a. Restrain mechanical joint fittings used with AWWA C900 PVC pipe with the EBAA Iron MEGALUG® Series 2000 PV Restrainer or an equal approved by the Contracting Officer. Ensure that the Series 2000 PV restrainers provide a minimum of 150-psi restraint with a 2 to 1 safety factor. Ensure that the restraining device and Tee head bolts are manufactured of high-strength ductile iron meeting ASTM A 536, Grade 65-42-10. Ensure that clamping bolts and nuts are manufactured of corrosion-resistant, high-strength, low-alloy CORTEN steel meeting the requirements of ASTM A 242/A 242M. Also restrain joints on either side of fittings in accordance with Restrained Joint Table, Spec EBAA 1500, in drawings.

b. Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 90 00.00 98 PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

2.1.1.3.2 Gaskets for AWWA C900 PVC Pipe

Gaskets shall be compatible with potable water pipe service. Gaskets shall be EPR, Viton ETP, or an approved equal. Wherever contaminated groundwater or contaminated soils are present, gaskets shall be Viton ETP, or an approved equal. Refer to drawings for locations.

Gaskets for flanged PVC joints shall be full faced, 1/8-inch thick, having a Brinell Hardness of 50 to 70 durometer A. PVC flanges shall be Vanstone flanges.

2.1.1.3.3 3-Inch and Smaller PVC Pipe

Provide pipe that is Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and ASTM D 1785.

Provide pipe that bears the NSF logo for potable water use.

2.1.1.3.4 Solvent Cement in Other than Chemical and Chemical Carrier Water Service

Solvent cement for socket joints shall comply with ASTM D 2564 and ASTM F 656.

2.1.1.3.5 Solvent Cement in Chemical and Chemical Carrier Water Service

Solvent cement shall be free of silica. Products: IPS "Weld-On 724" or Oatey "Low VOC PVC Heavy Duty Gray."

2.1.1.4 Joints and Fittings for PVC Pressure Pipe

2.1.1.4.1 4-Inch PVC Pressure Pipe Joints

Ensure that pipe joints are made with integral bell and spigot pipe ends. Ensure that the bell consists of an integral thickened wall section designed to be at least as strong as the pipe wall. Supply the bell with a factory glued rubber ring gasket which conforms to the manufacturer's standard dimensions and tolerances. Ensure that the gasket meets the requirements of ASTM F 477. Ensure that the PVC joints are "Ring-Tite" as manufactured by J-M Manufacturing Company, Inc. or an equal approved by the Contracting Officer. Ensure that nontoxic gasket lubricant is as specified by the pipe manufacturer.

2.1.1.4.2 3-Inch and Smaller PVC Pipe Joints

Socket weld pipe and fitting joints except where threaded and flanged joints are required to connect to valves and equipment.

2.1.1.4.3 4-Inch PVC Pressure Pipe Fittings

Ensure that fittings for use with AWWA C900 4-inch PVC pipe are ductile-iron fittings conforming to the requirements of mechanical joint fittings as specified in Part 2.1.1.1 of this Section.

Ensure that exterior coating for fittings is as specified in Part 2.1.1.1 of this Section.

Lining:

a. Ensure that lining for fittings is as specified in Part 2.1.1.1 of this Section.

b. Repair any damaged lined areas in accordance with the manufacturer's recommendations so that the repaired area is equal to the undamaged lined areas.

2.1.1.4.4 3-Inch and Smaller PVC Pipe Fittings

Ensure that fittings are Schedule 80 and conform to ASTM D 2464 for threaded fittings and ASTM D 2467 for socket-type fittings.

2.1.1.4.5 3-Inch and Smaller PVC Pipe Unions

Ensure that unions have socket-type ends, Viton O-rings, and are Schedule 80. Ensure that material is Type I, Grade 1 PVC in accordance with ASTM D 1784.

2.1.1.5 Flexible Polyester Reinforced Clear PVC Tubing/Hose

Provide NSF/ANSI 61 compliant clear PVC tubing with polyester reinforcement with smooth inside bore and smooth outside. Minimum operating pressure rating at 70 degrees F shall be 200 psi for tubing 3/4 inch and smaller, 150 psi for 1 inch, 100 psi for 1-1/4 and 1-1/2 inches, and 75 psi for 2-inch-diameter tubing. Burst pressure shall be at least four times the specified operating pressure.

For tubing size 1 inch and less, join tubing to rigid pipe with PVC adapter fittings, single-barb insert by Schedule 80 PVC solvent cement socket. Secure tubing to the barbed end of the fitting with stainless steel hose clamp. Connect tubing sections by means of single-barb PVC couplings with stainless steel clamps.

Products: Ryan Herco heavy duty "Herco-Braid Clear PV Tubing with Polyester Reinforcement" or approved equal.

2.1.1.6 HDPE Pipe and Fittings

Provide a statement in writing from the HDPE pipe manufacturer that the manufacturer is listed with the Plastic Pipe Institute as a qualified extruder for the polyethylene resin to be used in the manufacture of the pipe for this project. Ensure that the performance requirements of the pipe comply with the most current version of AWWA C901 or AWWA C906. Ensure that the manufacturer is listed with NSF/ANSI 61 certification and include the third party certification in the print line of the product.

All persons making heat fusion joints shall receive training in the manufacturer's recommended procedures. The Contractor shall maintain records of trained personnel and certify that training was received not more than 12 months before construction began. Additionally, the Contractor shall have worked on one or more projects involving combined installation of at least 10,000 feet of HDPE butt-fusion-welded pipe and shall provide the Contracting Officer with a written list of HDPE pipeline installation experience, including project location, date, Owner, and personnel assigned and installing on this project.

2.1.1.6.1 Quality Assurance

The pipe and fitting manufacturer(s) shall have an established quality-control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rated, and contamination.

2.1.1.6.2 Pipe and Fittings

General

All HDPE shall be Performance Pipe PE 3408 HDPE, PolyPipe PW PE 3408 HDPE, or approved equal and conform to ASTM D 3350.44576C cell classification.

All HDPE pipe 4 inches in diameter or greater shall have a ductile iron pipe outside diameter in accordance with ASTM F 714, and HDPE pipe 3 inches in diameter and smaller shall be IPS in accordance with ASTM F 714, unless otherwise specified or shown in the drawings.

HDPE Pipe

HDPE pipe 4 inches in diameter and larger shall conform to ASTM D 3350 445576 cell classification rated as PE 3408 by the Plastics Pipe Institute. Minimum pressure rating shall be as specified in this Section. Minimum pressure rating shall be 100 psi SDR 17 (standard dimension ratio) for pipe sizes greater than 4 inches in diameter. For pipe sizes 4 inches and smaller in diameter, the minimum pressure rating shall be 200 psi SDR 9.

The polyethylene compound shall be suitably protected against degradation by ultraviolet light.

The maximum allowable hoop stress shall be 1,000 psi at 73.4° F.

The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the requirements of the resin manufacturer to manufacture pipe from the resin used in accordance with PPI TR-4.

Fittings

HDPE pipe fitting shall conform to ASTM F 2206. The pipe manufacturer shall mold or fabricate the polyethylene fittings. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe.

Molded Fittings: Molded fittings shall be manufactured in accordance with ASTM D 3261 and shall be so marked. Each production lot of molded fittings shall be subjected to the test required under ASTM D 3261. The manufacturer shall submit samples from each molded fitting production lot to x-ray inspection for voids and shall certify that voids were not found.

Fabricated Fittings: Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full-service pressure rating of the mating pipe. Pressure de-rated fittings are not acceptable. Directional fittings 16 inches IPS and larger, such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets. Ensure that fittings fabricated from thicker wall pipe have an ID taper bore to match the wall of the pipe to which it will be fused.

HDPE Pipe Jointing Method

HDPE pipe shall be jointed by butt fusion in accordance with PPI TR-33 and the pipe manufacturer's directions and only for pipe within one SDR ratio of each other.

For SDR ratios that are two or more apart (i.e., SDR 21 to an SDR 11), the joint shall be made using restrained joints. Same-diameter pipe may be joined by using HDPE flange adapters and backup rings bolted to each other. The thicker wall pipe may also have an ID taper bore to match the wall of the thinner wall pipe to which it will be fused.

All HDPE pipe joined by butt fusion shall be made from the same class and type of raw material made by the same raw material supplier.

Butt fusion means the butt joining of the pipe by heat fusion aligned faces of the pipe ends (butts) in a suitable apparatus and joining under controlled pressure and alignment.

The external bead resulting from the butt-fusion process shall be visible and examined for complete butt-fusion 360 degrees around the pipe exterior.

Short spools of pipe between valves and fittings shall be ductile iron pipe, with all joints restrained for sizes 4 inches and larger. For 2-inch pipe, the spool shall be Schedule 40 Type 304 stainless steel piping or Schedule 80 PVC piping with IP threads stainless steel or PVC fittings and all joints restrained.

Where approved by the Contracting Officer, the HDPE pipe and fittings may be fused with Electrofusion Couplings, as manufactured by Central Plastics Company, or approved equal. Technical information must be provided to demonstrate that the fused coupling will not compromise the structural integrity of the HDPE pipe.

2.1.1.7 Ductile Iron Pipe for HDD

2.1.1.7.1 General

Ductile iron pipe used for directional drilling shall meet all requirements of ANSI/AWWA C151/A21.51. Unless otherwise specified pipe shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4, with all operations completed in a single facility by one manufacturer. Pipe shall be AMERICAN Flex-Ring® or approved equal.

2.1.1.7.2 Pipe Joints

Joints used for directional drilling shall be boltless, flexible restrained, with smooth contoured bells and shall have the minimum properties as shown in Table 1. Joints with bulky glands or flanges that may prevent the smooth flow of the drilling fluid/soil slurry over the joint are not acceptable. Pipe shall be AMERICAN Flex-Ring® or approved equal.

a. Pressure and Thrust (Pulling): Joint seals and Flex-Ring® joint pipe used for HDD, when properly assembled and installed, shall be capable of dependably handling the specified internal pressure and pulling loads in straight alignment or at maximum rated joint deflection. Maximum internal pressure and allowable pulling loads for all sizes are provided in Table 1.

b. Proof-of-Design Tests: The manufacturer shall make available to the Contracting Officer proof-of-design tests for each size and type of flexible restrained joint pipe used. These tests shall establish the basis for the maximum allowable pulling loads shown in Table 1. Proof-of-design tests for the pulling heads shall also be made available to the Contracting Officer.

2.1.1.7.3 External Loads and Buckling

In cases where the borepath alignment is at an extreme depth or if the Contractor anticipates high pumping pressures particularly for larger sizes of pipes, the Contractor shall consult the pipe manufacturer to ensure that the buckling strength of the pipe has been properly evaluated.

2.1.1.7.4 Lining and Coating

Ductile iron pipe for water service shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4.

Ductile iron pipe for wastewater service and for application as culvert pipes shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4 unless otherwise specified.

The exterior of all ductile iron pipe and fittings shall be coated with an asphalt-based coating as required by ANSI/AWWA C151/A21.51.

2.1.1.7.5 Pipe Weight - Net Unit Buoyancy

Pipe buoyant force or buoyant weight shall be calculated based on the density of drilling fluid(s) to be used. Any counter-weight placed inside the pipe shall be free from any dirt, grease, oil, or other contaminants that may prevent proper disinfection for waterlines.

TABLE 1 - FLEX-RING® DIMENSIONS AND OTHER PARAMETERS

Nominal Pipe Size (inch)	Maximum Working Pressure [1] (psi)	Pipe Barrel O.D. (inch)	Pipe Bell Outside Diameter (inch)	Unit Weight Lined PC 350 Pipe (lb/ft)	Bulk Density of Empty Pipe (lb/ft3)	Net Unit Buoyancy [2], Empty Pipe in Water (lb/ft)	Allowable Pulling Loads (lb)	Allowable Deflection (Deg.)
4	350	4.80	7.06	13	100	-5	10,000	5
6	350	6.90	9.19	18	69	-2	20,000	5
8	350	9.05	11.33	25	55	3	30,000	5
10	350	11.10	13.56	31	46	11	45,000	5
12	350	13.20	15.74	40	42	19	60,000	5
14	350	15.30	19.31	53	41	27	75,000	4
16	350	17.40	21.43	65	40	38	95,000	3.75
18	350	19.50	23.70	78	37	52	120,000	3.75
20	350	21.60	25.82	90	35	69	150,000	3.5
24	350	25.80	29.88	122	34	104	210,000	3
30	250	32.00	36.34	173	31	175	220,000	2.5
36	250	38.30	42.86	233	29	266	310,000	2
42	250	44.50	49.92	315	29	359	390,000	2
48	250	50.80	56.36	395	28	484	500,000	2

[1] Working pressure is the maximum pressure rating of the joint and is based on its capability to resist thrust due to internal pressure. If higher working pressure is required, check with AMERICAN. Pressure rating of the joint is limited by the pressure rating of the parent pipe.

[2] Based on weight of empty (full of air) Pressure Class 350 Flex-Ring pipe with standard cement lining immersed in water. Positive numbers indicate such pipe will float.

2.1.1.7.6 Entry and Exit Angles

The entry angle of the drill string shall range from 8 degrees to 20 degrees. Exit angles for the drill string shall consider the allowable deflection (reference Table 1) and the method of installation proposed for the new Flex-Ring®, flexible restrained joint ductile iron pipe. Submit a detailed connection plan showing the connection between the HDD installed piping and the next section of pipeline.

2.1.1.7.7 Minimum Radius of Curvature

Maintain the borepath alignment and radii that are indicated on the drawings. Any alternate designs must be submitted to the Contracting Officer for approval before beginning drilling operations and shall be based on a range from 50 feet to 100 feet per inch of nominal diameter, using 20-foot joint lengths.

2.1.1.7.8 Borepath Inside Diameter

The finished inside diameter of the borepath shall be nominally 1.5 times the outside diameter of the Flex-Ring® bell (see Table 1) for pipe sizes 4 inches through 24 inches. The inside diameter of the borepath for pipe sizes 30 inches through 48 inches shall be equal to the outside diameter of the Flex-Ring® bell (see Table 1) plus 12 inches. To ensure proper borepath size and integrity, the borepath shall be swabbed before final pipe pullback.

2.1.1.7.9 External Protection

a. Polyethylene (PE) Encasement: Apply PE encasement according to the following procedure. Using only tube-type PE sleeves, the PE tube shall be centered onto the barrel of the pipe and firmly secured in accordance with the requirements of AWWA C105/A21.5, Method A and other requirements as described below. Ensure that all excess material along the barrel of the pipe is creased and the excess folded over itself longitudinally so that the PE wrap is tight up against the pipe barrel. Secure the wrap tightly to the pipe by applying circumferential wraps of tape applied over the folded PE encasement, and applied at intervals of approximately 2 feet to within 18 to 24 inches of either end of the pipe. Tape applied in a helical pattern should only be used as a supplementary wrap.

b. The excess PE encasement shall be pulled back over itself to expose approximately 18 to 24 inches of both ends of the pipe. First overlap the PE encasement so that this first layer can be securely anchored to the pipe barrel, without interference from the PE encasement on that pipe section, using tape. The excess material should be trimmed, or the length and/or positioning of the PE tube may need adjustment to accomplish this.

c. After engaging the spigot into the bell and verifying engagement of the restraining Flex-Ring® or Flex-Ring® segments, the following sequence is recommended for securing and completing the PE encasement at the pipe joints. This sequence should be followed so that the final overlap is made opposite the direction of the pull, preventing any catching of the edge and minimizing any collection of drilling fluids etc. inside the wrap. For each layer of PE encasement always complete the joint by first overlapping the end of the tube from the spigot end over the bell and secure the end of the tube onto the pipe barrel with several contiguous circumferential wraps of tape. It is important to ensure that the PE encasement is secured to the pipe barrel with enough circumferential wraps to anchor the PE encasement so that any possibility of slippage is reduced. The PE encasement from the pipe closest to the HDD drilling machine (bell end of pipe) shall then be overlapped over its bell and secured to the barrel on the spigot end of the pipe being installed with circumferential wraps of tape.

d. Apply one final, tight circumferential wrap a few inches from the bell face on the last PE wrap overlap over the most recently assembled spigot end. This final wrap should consist of strong strapping tape or other firm fastening means (that will not damage the wrap) and that will further minimize any slippage or bunching of the wrap-in installation. Any other proposed methods of installing and fastening PE encasement must be approved by the Contracting Officer.

2.1.1.8 Galvanized Steel Pipe

Pipe: Steel piping shall conform to the requirements of ASTM A 53/A 53M, Type S, Grade B, and ASME B36.10, Schedule 40 as indicated on the drawings.

Fittings: Forged steel conforming to ASTM A 105/A 105M and ASME B16.11, Class 2000.

Joints: Threaded conforming to ASME B1.20.1.

Galvanizing: Conform to ASTM A 90/A 90M.

2.1.1.9 Stainless Steel Pipe and Fittings

2.1.1.9.1 Pipe

Pipe 3 inches and larger shall conform to ASTM A 312/A 312M, Grade TP 304L.

Pipe sizes and wall thicknesses shall conform to ASME B36.19M as follows:

Pipe Size	Wall Thickness
1-1/4 inches through 3 inches	Schedule 80S
3-1/2 inches through 8 inches	Schedule 40S

2.1.1.9.2 Fittings

Fittings 3 inches and smaller shall be socket welded, conforming to ASME B16.11, 3,000-pound CWP. Material for socket-welded fittings shall conform to ASTM A 403/A 403M, Class WP 304L or ASTM A 182/A 182M, Grade F304L.

Fittings for buried or submerged pipe that are 4 inches shall be butt-welded, conforming to ASTM A 403/A 403M, Class WP or ASTM A 774/A 774M, the same material and wall thickness as the pipe, conforming to ASME B16.9. Elbows shall be long radius.

2.1.1.9.3 Preparation and Final Cleaning

Pipe and fittings shall be final cleaned, pickled, and passivated in accordance with ASTM A 380. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of the stainless steel by a chemical dissolution, a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean if there is any evidence of rusting.

2.1.1.9.4 Quality Control

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530/A 530M.

2.1.1.9.5 Unions

Unions shall be 3,000-pound WOG-forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be socket-welded type. Material shall conform to ASTM A 182/A 182M, Grade F304L for socket-welded type.

2.1.1.9.6 Joints

Joints for pipes 3 inches and smaller shall be socket welded, the same material as specified for fittings, 3,000-pound WOG, conforming to ASME B16.11.

Joints for buried or submerged pipe larger than 3 inches shall be butt-welded.

Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

2.1.2.1.1 Cast-Iron Resilient Wedge Gate Valves, 2 Inches through 3 Inches, Threaded End (AWWA C509)

Provide valves 2 inches through 3 inches that are of cast-iron or ductile-iron body construction and conform to AWWA C509 for resilient seated gate valves. Provide the valve design that incorporates non-rising stems and triple "O" ring seal staff box. Provide valves that open counterclockwise. Ensure that the valve wedge is symmetrical and fully encapsulated with molded rubber with no exposed iron. Design valves for bubbletight shutoff to flow in either direction. Before shipment the valve manufacturer shall test each valve to 200-psi pressure differential in both directions and provide a certificate to the Contracting Officer stating each valve provided bubbletight shutoff during testing. Ensure that the valve interior and exterior is epoxy fusion coated.

Ensure the ends are threaded ends complying with ASME B1.20.1.

Gate valves shall be manufactured by Mueller, American Flow Control or Kennedy.

2.1.2.1.2 Ductile-Iron Resilient Wedge Gate Valves, 3 Inches through 20 Inches, for Exposed and Buried Service (ANSI/AWWA C515)

Provide valves that are cast-iron or ductile-iron body valves and comply with ANSI/AWWA C515 and the following. Ensure that valves are of the bolted-bonnet type with nonrising stems. Ensure that the valve gate is of ductile-iron with a resilient wedge. Ensure that valve stems are Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Ensure that stem nuts are made of solid bronze. Ensure that bronze conforms to ASTM B 62 or ASTM B 584. Ensure that body bolts are Type 316 stainless-steel. Ensure that end connections for exposed valves are flanged. Ensure that end connections for buried valves are mechanical joint type. Provide reduction-thrust bearings above the stem collar. Ensure that stuffing boxes are O-ring seal type with two rings located in the stem above the thrust collar. Ensure that each valve has a smooth unobstructed waterway free from any sediment pockets. Ensure that valves are lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Ensure that minimum epoxy thickness is 8 mil.

Gate valves 16 inches and larger will include an integrated bypass gate valve with a minimum diameter of 1.5 inches. The integrated gate valve shall meet the requirements of Part 2.1.2.1.1. All piping associated with the bypass gate valve is Type 316 stainless steel.

Manufacturers: Clow, AVK, American Flow Control, Kennedy, or approved equal.

2.1.2.2 Slanting Disc Check Valve

Slanting disc check valves 6 inches through 72 inches shall have materials of construction as described below:

Component	Material	Specification
Body	Cast or ductile-iron	ASTM A 126, Class B or ASTM A 536, Grade 65-45-12
Seat ring and disc ring	Bronze	See the following specification
Pivot pins	Stainless-steel	ASTM A 582/A 582M, Type 303 or 304
Bushings	Stainless-steel	ASTM A 269, Type 304 or 316
Oil reservoirs	Stainless-steel	AISI Type 316

Bronze or brass components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7 percent maximum
Aluminum	2 percent maximum
Lead	8 percent maximum
Copper plus Nickel plus Silicon	83 percent minimum

Ends shall be flanged, ASME B16.1, Class 150. The body shall be of two-piece construction, bolted at the center to hold the seat at an angle of 55 degrees. The area throughout the valve body shall equal the full pipe area. Provide bottom-mounted hydraulic dashpot to control valve closing. The dashpot shall have a control valve to adjust the speed of the closing cycles. Time spreads shall be 1 second to 30 seconds for closing. Provide oil-filled dashpots to operate the closing arrangement over the last 10 percent of the closing range. The valve shall be APCO Series 800, Golden-Anderson, Val-Matic Series 9600, or approved equal.

2.1.2.3 Butterfly Valve

2.1.2.3.1 General Description

Butterfly valves shall meet or exceed AWWA C504, Class 150B, unless otherwise specified in this Section. Each valve shall operate in fully opened and in intermediate positions as the valve opens and closes without noticeable flutter or vibration of the disk and shall be free of backlash and loose connections in the operating mechanism, linkage, and shaft connections. Valves shall be identified properly by size, type, serial number, and manufacturer in stainless-steel plates attached permanently on the valve body or bonnet.

The valve body shall be ductile-iron according to ASTM A 536 Grade 65-45-12 or cast-iron according to ASTM A 48/A 48M. The valve disc shall be ductile-iron in accordance with ASTM A 536 (65-45-12) or cast-iron in accordance with ASTM A 48/A 48M. The disc seating edge shall be solid 316 stainless-steel. The disc shall be securely attached to the valve shaft using 304 stainless-steel taper pins. The valve disc shall be designed without using external reinforcing ribs. The valve disc shall provide an uninterrupted 360-degree seating edge. The valve seat shall be of EPDM or Viton materials. The valve seat shall be designed to provide a tight shutoff in both directions at the specified design differential pressure, with a pressure of 0 psig on the face of the disc opposite the pressurized side. The valve seat shall be molded in and bonded to the valve body for 3- to 24-inch valves. For valves 30 inches and larger, the seat shall be field replaceable without disassembly of the disc and shaft and shall be retained within a dovetail groove in the valve body and locked in place by an epoxy compound edge. The valve shaft shall be of Type 304 stainless-steel. The valve shaft may be a one-piece unit extending completely through the disc or of the stub shaft type consisting of two separate shafts inserted into the valve disc hubs. Stub shafts shall extend into the disc hubs for a distance of at least 1.5 shaft diameters. The valve shaft shall have a diameter equal to or greater than that shown for Class 150B in Table 3 of AWWA C504. Connection between the shaft and disc shall be dowel or taper pins, which are mechanically secured. Alignment marks on the valve shaft and on the valve body shall be provided to indicate the fully closed and fully open positions. Valve shaft bearings shall be Teflon-lined with a nonmetallic fiberglass composite backing and shall be permanently lubricated. The bearings shall be sleeve-type bearings contained in the hubs of the valve body. Design bearings in accordance with AWWA C504, Section 4.5.6. Thrust bearings shall be provided "as required" to hold the valve disc in the center of the valve seat. The valve shaft seal shall be self-compensating V-type packing with a minimum of four sealing rings. One-piece molded shaft seals and O-ring shaft seals are not acceptable. The shaft seal shall be designed to allow seals to be replaced without the valve shaft being removed. Packing shall be made of resilient, nonmetallic material and shall not contain asbestos. Metallic components (e.g., dowels, pins, etc.) shall be 300 series stainless-steel, ductile-iron, or other materials approved by the Contracting Officer. Brass, bronze, and copper alloy materials are not acceptable. Nonmetallic components shall be EPDM, Viton, Teflon, or other materials approved by the Contracting Officer.

Valves shall be as manufactured by DeZurik, Pratt, M&H, Val-Matic, or an approved equal.

2.1.2.3.2 Flanged, Rubber-Seated Butterfly Valves, 4 Inches through 72 Inches, for Exposed Service

The valve bodies shall have flanged ends. Flanged-end valves shall be designed with 125-pound flanged ends faced and drilled in accordance with ASME B16.1 for cast-iron flanges.

2.1.2.4 Combination Air Valve, Single Body

All valves shall meet or exceed all applicable provisions of the latest revision of ANSI/AWWA C512, Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service. All valves for drinking water services shall comply with NSF/ANSI 61. Design pressure is 150 psig.

All valves shall consist of a float or a float assembly. Valves shall be identified properly in plates attached permanently on the valve body. The body and cover shall be cast iron ASTM A 126, Class B; or ASTM A 48/A 48M, Class 35. Valves 3 inches and smaller shall have threaded ends. Valves 4 inches and larger shall have flanged ends. Threaded ends shall comply with ASME B1.20.1. Flanges shall comply with ASME B16.11, Class 125. All flanges shall be flat faced.

The float shall be Type 304 or 316 Stainless Steel. For valves with inlet sizes less than 4 inches, the float shall be capable of withstanding a collapse pressure of 1,000 psig. Trim shall be Type 304 or 316 Stainless Steel. The valve seat shall be of EPDM or other rubber materials that are applicable to water. The valve seat shall be easily removed and replaced in the field.

Drain/test ports on all valves with inlet size 1 inch or larger shall have two 1/2-inch NPT minimum plugged ports, one near the bottom of the valve body and the other near the top of the valve. The plug shall be of stainless-steel, ASTM B 584, Alloy C83600.

2.1.2.5 Transition Coupling--HDPE to Stainless Steel

HDPE to stainless steel transition coupling shall be capable of withstanding operating pressures of 150 psi. The transition coupling shall be the ETCO Specialty Products, Inc. E-Loc® Transition Coupling or approved equal.

2.1.2.6 Air-Release Valves for Water Services, Compound Lever

Air-release valves for water services shall be inlet size 1 inch and 2 inches, of a compound lever with linkage mechanism to release air, Class 300. Orifice size shall be 1/8 or 3/32 inch. Valves shall be APCO 200A, Val-Matic Model 38, or approved equal.

2.1.2.7 Ball Valves

2.1.2.7.1 Stainless Steel Ball Valves

Stainless steel ball valves, 2 inches and smaller, shall be rated at a minimum pressure of 1,500 psi WOG at a temperature of 100 degrees F. Valve body shall be 300 Series stainless steel, NSF/ANSI 61 approved. Ball shall be Type 316 stainless steel. Seat and seals shall be reinforced Teflon. Valves shall have lever handle, plastic coated. Valves shall have screwed ends (ASME B1.20.1) and nonblowout stems. Valves shall be McCanna M402, Worcester Series 48, Stockham SD 2120-CS, Apollo 73-100 Series, or approved equal.

2.1.2.8 Double-Union PVC Ball Valves, 3 Inches and Smaller, with Vented Ball for Chemical Service

Vented PVC ball valves 3 inches and smaller for chemical service shall be rated at a pressure of 230 psi at a temperature of 70 degrees F and 150 psi at a temperature of 105 degrees F. Provide a machined vent hole, deburred, in the ball to allow gases to vent. Body, ball, and stem shall be PVC conforming to ASTM D 1784, Cell Classification 12454-A. Stems shall have double O-rings and be of blowout-proof design. Seats shall be PTFE and shall have an elastomeric backing cushion of the same material as the valve seals. O-ring seals shall be FKM. Valve ends shall be of the double-union design. Ends shall be socket-welded except where threaded or flanged-end valves are specifically shown in the drawings. Valves shall have handles for manual operation. Valves shall be Asahi/America Type 21 or approved equal.

2.1.2.9 True Union PVC Ball Check Valves

True Union PVC Ball Check Valves shall have full port true union design. End connections shall be socket. Minimum working pressure rating shall be 150 psi at 70 degrees F. True Union PVC Ball Check Valves shall be Hayward Flow Control TC Series or approved equal.

2.1.2.10 Fire Hydrants

Fire hydrants shall be in accordance with AWWA C502, for dry barrel-type fire hydrants. Fire hydrants shall meet the following requirements:

Catalogue and maintenance data	Required.
Type of shutoff	Compression or gate
Size of hydrant (valve opening)	5.25-inch
Inlet connection	6-inch, verify with drawings.
Outlet nozzles	Two 2.5-inch hose and one 4.5-inch pumper.
Outlet nozzle threads	See Note 1.
Direction to open	Counterclockwise.
Stem seals	O-ring.
Outlet nozzle cap chains	Required.
Drain outlet, non-corrodible	Required.

Traffic breakaway body and valve rod	Required.
Working pressure rating	200 psi (minimum).
Fire hydrant wrenches	Provide five wrenches as spare parts.
Nozzle wrenches	Provide five wrenches as spare parts for each size nozzle provided.
Breakaway repair kit	Provide five kits as spare parts.

Notes: Outlet nozzle threads shall be the Government's standard fire hydrant thread. The Contractor shall verify thread type before submittal.

Hydrants shall have Underwriter's Laboratory (UL) and Factory Mutual (FM) approvals. Hydrant exteriors shall be painted with one coat of zinc-chromate alkyd primer and two finish coats of approved paint of the color required by the Government. Hydrant is to be painted Red 11105. Hydrant interiors shall be painted with a paint system approved by NSF for use in potable water. Working parts shall be bronze. All internal parts shall be removable through the top of the hydrant. Hydrants shall conform to NFPA 24.

Fire hydrant extensions shall be provided at no additional cost to the Government to meet final grade requirements. All hydrants shall stand plumb. No portion of the fire hydrant shall be within 6 inches of a sidewalk. After installation, all hydrants shall be inspected, cleaned, and opened and closed as many times as required to verify that all aspects of the hydrant work properly.

Fire hydrants shall be M&H, Kennedy, Mueller, American Darling or approved equal.

2.1.2.11 Indicator Posts

UL 789. Provide for gate valves where indicated. The face of the indicator post shall face the nearest roadway, driveway, or parking lot.

2.1.2.12 Valve Boxes

Valve boxes shall be cast iron, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with slide adjustments and with flared bases. Concrete boxes shall be constructed in accordance with details indicated. The word "WATER" shall be cast in the cover. Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Concrete boxes may be installed only in locations not subjected to traffic.

2.1.2.13 Unions

No attempt has been made to show all unions required for the project. The Contractor shall provide unions at all connections of threaded pipe to installed equipment unless deleted by the Contracting Officer, in writing, at certain locations. The unions shall meet or exceed the quality of materials, pressure rating, service, and painting requirements of connected piping.

2.1.2.14 Warning Tape and Tracing Wire for Buried Piping

Warning tape and tracing wire for buried pipe is specified under Section 31 00 00 EARTHWORK.

2.1.2.15 Water System Identification Tags

Provide a coordinated system of piping and equipment identification which includes metal-tag-identified major valves, piping-system components, and equipment.

Install identification tags made of stainless steel and indicating function of valve or similar component on such system devices. Tags shall be not less than 2 inches in diameter and the marking shall be stamped.

Provide equipment with metal identification tags bearing an equipment designation number provided by the Government and matching the drawing designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

2.1.2.16 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36/SA-36M
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.1.2.17 Mechanical Joint Tapping Sleeve

Mechanical joint tapping sleeve shall be iron body with 3/4-inch NPT test plug and shall be of the proper style to fit most types of pipe including cast iron, ductile iron, A-C, and steel pipe as required. Standard mechanical joint ends shall comply with AWWA C111/A21.11. Minimum pressure rating shall be 250 psi. All sleeves shall have outlet flange with dimensions and drilling that comply with ASME B16.1, Class 250. The Contractor shall field measure the outside diameter of the pipe to be tapped prior to submitting the tapping sleeve submittal. Sleeves shall be mechanically attached to the water main. Lead caulking shall not be allowed.

2.1.2.18 Tapping Valves

Provide resilient wedge gate valves with mechanical and flanged ends in accordance with requirements of ANSI/AWWA C515. Comply with requirements of ASME B16.1 for inlet flange and with AWWA C111/A21.11 for mechanical joint outlet. The minimum pressure rating shall be 250 psi. One end shall have slotted bolt holes in accordance with ANSI/AWWA C515, Paragraph 4.4.1.3.4 to fit tapping machines. Valve body shall be iron, bronze fitted. Valves shall be of the bolted bonnet type with nonrising stems.

Valve stems shall be Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Stem nuts shall be made of solid bronze. Bronze for internal working parts, including stems, shall conform to ASTM B 62 or ASTM B 584 (Alloy C83600), except that the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10 percent elongation in 2 inches (ASTM B 584 or ASTM B 763, Alloy C87600 or C99500). Body bolts shall be Type 316 stainless-steel. Provide reduction-thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in the stem above the thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets. Provide valve with a 2-inch square nut, operator, and valve box. Epoxy coat the interior of the valves in accordance with AWWA C550. The exterior shall be epoxy coated by the manufacturer at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mil. Before shipment from the factory, hydrostatically pressure test the valve to the requirements for both AWWA and ULC. Submit the test results to the Contracting Officer for approval.

2.1.2.19 Sleeve-Type Mechanical Couplings

Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. For ductile iron pipe, the middle ring shall be of cast-iron or steel; and the follower rings shall be of malleable or ductile iron. Malleable and ductile iron shall, conform to ASTM A 47/A 47M and ASTM A 536, respectively. Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type, ASTM A 307, Grade A, with nuts, ASTM A 563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Bolts shall be a minimum of 5/8 inch in diameter.

2.1.2.20 Flanged Coupling Adapters

Adapters shall consist of a cast-iron or high-strength steel body, two steel or ductile iron follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

3-24-inch DIP Flange Adapters

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect.

Flanges: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect. Bolt circles and bolt holes shall match those of ASME B16.1 Class 125 flanges.

Bolts and nuts: Alloy to AWWA C111/A21.11

Gasket: Grade 27 BUNA-S.

Acceptable Manufacturers:

Dresser Manufacturing Division of Dresser Industries, Inc.;
Dresser Style 128W or approved equal.

2.1.2.21 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36/SA-36M
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.;
Dresser Styles 62 and 162 or approved equal.

2.1.2.22 Retainer Glands

Provide retainer glands for all buried ductile-iron mechanical joints, fitting, and ductile-iron pipe connections to buried valves. Design retainer glands for joint retaining through the use of a follower gland and set screw-anchoring devices which impart multiple wedging action against the pipe. The mechanical joint restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

1. Gland: Manufactured of ductile iron conforming to ASTM A 536. Gland dimensions shall match AWWA C111/A21.11 and ANSI/AWWA C153/A21.53.

2. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Incorporate a set screw/twist-off nut bolt into restraining devices to ensure the proper actuating of the restraining device. Design the twist-off nut to come off at the torque limit desired to anchor the restraining device in place on the pipe.

3. Joint Deflection: Limit retainer gland joint deflection to manufacturer's recommended maximum deflection angle. Apply joint deflection before the set screws are torqued.

4. Acceptable manufacturers:

   a. EBAA Iron, Inc.; Megalug 1100 Series or approved equal.

2.1.2.23 Restraining Harness

Provide ductile iron pipe push-on (bell and spigot) joint restraint by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Provide torque limiting twist-off nuts on each wedge to ensure proper applied installation torque. Make the split ring from 60-42-12 ductile iron conforming to ASTM A 536. Make steel connecting rods conforming to AWWA C111/A21.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have a 350-psi maximum working pressure rating and a 18- to 36-inch diameter restraining harnesses shall have 250-psi maximum working pressure rating. Design all harnesses with a 20-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers:

EBAA Iron, Inc.; Series 1700 or approved equal.

2.1.2.24 Pump Expansion Joint Couplings (Metallic Bellows Flexible Connectors)

Booster pump suction flexible connectors shall be corrugated metal bellows-type expansion joints reinforced with equalizing/control rings.

Expansion joints shall conform to the EJMA Stds in all respects. Bellows elements shall be formed by the hydro forming process. Expansion joints shall be supplied with equalizing/control rings of the bolted type. Bellows convolutions shall be 2 inches in pitch and height, minimum. Provide all bellows designs with bellows calculations and submitted for record purposes which conform to the EJMA Stds, including cycle life. Hydro-test bellows to 1-1/2 times the design pressure, minimum. The bellows shall not exhibit any signs of squirm. Devices such as flow liners, covers, hinge or gimbal hardware, etc., shall not be used to prevent (or mitigate) the effects of squirm during hydro testing.

The expansion joints shall have a design pressure rating of at least 200 psig and shall be furnished with van-stone-type flanged ends with 125-pound drilling.

Each expansion joint shall be furnished with an inner flow liner than shall be suitable for the conveyance of potable water at velocities of up to 20 fps in either direction through the expansion joint.

Materials of construction shall be as follows:

Bellows:	304 stainless-steel
Liner:	304 stainless-steel
Equalizing/control rings:	304 stainless-steel
Collars/bands:	304 stainless-steel
Flange plates:	Carbon steel

Welded stainless-steel components shall be made of low-carbon-type stainless-steel.

Each expansion joint shall enable a limited gap to be obtained in the flanged joint connections to facilitate pump installation/removal. Design each expansion joint to provide the following concurrent movements as a minimum:

Compression:	3/4 inch
Lateral offset:	1/8 inch
Angular rotation:	Flange faces parallel within 1/8 inch

Factory precompress expansion joints as necessary to facilitate installation. Installed lay length shall be as specified herein.

Equip each expansion joint with a tie rod/restraint system designed to limit the axial deflection of the entire flexible connector assembly to no more than 0.005 inch with the piping system subjected to 200 psig pressure. Submit axial deflection calculations for record purposes. Position cotter pins to prevent excessive tie rod nut travel and extension of the flexible connectors beyond their allowable axial movement range. Equalizing/control rings shall prevent excessive compression of the flexible connectors beyond their allowable axial movement range. Double-nutting of the tie rods using jam nuts and heavy hexagonal nuts on/against each side of each plate flange shall lock the position of the connector and prevent tie rod nuts from loosening during system operation, yet allow loosening/resetting in the event of future pump removal/reinstallation. The tie rod/restraint system shall be reviewed by the pump manufacturer and shall comply with the pump manufacturer's recommendations for the proposed pump/piping configuration.

Store, handle, align, and install expansion joint in conformance with the manufacturer's recommendations.

1. Provide a copy of the manufacturer's installation recommendations to the Contracting Officer at the time of expansion joint installation.

2. Align the piping and each expansion joint during installation so that no axial, lateral, or torsional deflection is imposed. Expansion joints shall not be used to correct piping misalignment. All piping shall be laid true so that the expansion joint end fittings mate perfectly with connecting pipe and/or equipment. The Contractor shall demonstrate this alignment to the Contracting Officer during assembly.

3. Provide all temporary spacers/bracing as necessary to provide proper alignment and installation and to maintain the preset compression traverse. Upon completion of the installation, position/tighten tie rod inner and outer nuts bearing against the faces of each plate flange along with their associated jam nuts according to the manufacturer's instructions, providing a tied/locked assembly that prevents movement.

4. Install each expansion joint compressed axially 1/4-inch of the available 3/4-inch; this position is the lay length indicated on the drawings. The provided expansion joints shall be fully compatible with the installation conditions and geometry shown on the drawings. The expansion joints shall be manufactured by Senior Flexonics, Inc., Expansion Joint Division of New Braunfels, Texas.

2.1.2.25 Hanger and Support Systems

2.1.2.25.1 General

Not all pipe supports or hangers required are shown on the drawings. Provide pipe supports for every piping system installed. Support piping by pipe support where it connects to pumps or other mechanical equipment.

Ensure that pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes, fittings, and valves (all filled with water) plus valve actuators and any insulation and shall have a minimum safety factor of 5 based on the material's ultimate strength.

All of the equipment specified in this Section is intended to support the various types of pipe and piping systems. The details shown on the drawings are intended to indicate the generally desired methods of support under normal conditions. Develop final details and any details associated with special conditions not already covered to meet the system conditions specified in the respective Division 22 Pipe Sections.

Support all pipe and tubing as required to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS and shall be furnished and installed under this Section.

Space hangers and supports in accordance with ASME B31.1 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified in this Section.

Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc. shall be rigidly supported.

Support all pipe and appurtenances connected to the equipment so as to prevent any strain from being imposed on the equipment or piping system.

Furnish all rods, clamps, hangers, inserts, anchor bolts, brackets, and components for interior pipe supports with galvanized finish, hot-dipped, or electro-galvanized coated, except where field welding is required. Plastic coat interior clamps on plastic pipe. Provide copper-plated supports for copper pipe or shall have a 1/16-inch plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for exterior pipe and pipe within outdoor structures shall be of Type 316 stainless-steel.

Supports shall be sufficiently close together so that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.

Protect all uninsulated nonmetallic piping such as PVC, CPVC, etc., from local stress concentrations at each support point. Provide protection by galvanized steel protection shields or other method as approved by the Contracting Officer. Where pipes are bottom supported 180 degrees, furnish arc shields. Where 360-degree support is required, such as U bolts, provide protection shields for the entire pipe circumference. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length, and be securely fastened to pipe with stainless-steel or galvanized metal straps not less than 1/2-inch wide.

Furnish all insulated pipe with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide galvanized protection shields as specified in this Section at each location.

Where pipe hangers and supports come in contact with copper piping, provide protection from galvanic corrosion by wrapping pipe with 1/16-inch-thick neoprene sheet material and galvanized protection shield or copper-plated or PVC-coated hangers and supports.

Provide pipe supports as follows:

1. Support cast-iron and ductile-iron piping at a maximum support spacing of 10 feet with a minimum of one support per pipe section at

the joints.

2. Support steel and stainless-steel piping 2-1/2 inches or larger diameter at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.

3. Support spacing for steel and stainless-steel piping 2 inches and smaller diameter and copper tubing shall not exceed 5 feet.

4. Supports for multiple PVC plastic piping shall be continuous wherever possible. Support individually supported PVC pipes as recommended by the manufacturer except that support-spacing shall not exceed 3 feet. Where possible, support multiple, suspended, horizontal plastic PVC pipe runs by ladder-type cable trays such as the Electray Ladder by Husky-Burndy; Cable Tray by Enduro Composite Systems; the Globetray by the Metal Products Division of United States Gypsum or approved equal. Ladder shall be of FRP construction. Run spacing shall be 12 inches. Tray width shall be approximately 6 inches for single runs and 12 inches for double runs. Furnish ladder-type cable trays complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Secure individual plastic pipes to the rungs of the cable tray by strap clamps, or fasteners similar to Globe, Model M-CAC; Husky-Burndy, Model SCR; or approved equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

5. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.

6. Provide supports at changes in direction and elsewhere as shown on the drawings or as specified in this Section. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Contracting Officer.

7. Provide pipe supports to minimize lateral forces through valves, both sides of split-type couplings, and sleeve-type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be used to support connecting pipes.

8. Account for effects of thermal expansion and contraction of the pipe in the pipe support selection and installation.

Fabricate or construct any required pipe support for which the supports specified in this Section are not applicable from standard structural steel shapes and concrete and anchor hardware similar to items previously specified in this Section and shall be subject to the approval of the Contracting Officer.

2.1.2.25.2 Hanger and Support Systems

Pipe hangers and supports shall be as manufactured by Anvil, Unistrut, Cooper B-Line, Aikinstrut, Superstrut, or approved equal.

Pipe hangers and supports shall comply with MSS SP-58 for the standard types references on the drawings. Construct special hangers and supports if detailed in the drawings. Type numbers for standard hangers and supports shall be in accordance with MSS SP-58 as listed below:

Type Number	Description	Manufacturer and Model (or Equal)
1	Adjustable steel clevis	Anvil Fig. 590 or 260, B-Line B3100 or B3102
3	Steel double-bolt pipe clamp	Anvil Fig. 295A or 295H, B-Line B3144 or B3144A
4	Steel pipe clamp(pipes smaller than 3 inches)	Anvil Fig. 212, B-Line B3140
4	Steel pipe clamp (pipes 3 inches and larger)	Anvil Fig. 216, B-Line 3142
5	Pipe hanger	B-Line B6690
6	Adjustable swivel pipe ring	Anvil Superstrut 714, Anvil Fig. 104
7	Adjustable steel band hanger	B-Line B3172
8	Extension pipe or riser clamp	Anvil Fig. 261, B-Line B5573
9	Adjustable band hanger	Anvil Fig. 97
10	Adjustable swivel ring band hanger	Anvil Fig. 70, B-Line B3170 NF
11	Split pipe ring with adjustable turnbuckle	Anvil Fig. 108, B-Line B3173
13	Steel turnbuckle	Anvil Fig. 230, B-Line B3202
14	Steel clevis	Anvil Fig. 299, B-Line B3201
15	Swivel turnbuckle	Anvil Fig. 114, B-Line B3224
16	Malleable iron socket	Anvil Fig. 110R, B-Line B3222
17	Steel weldless eye nut	B-Line B3200
18	Steel or malleable iron concrete insert	Anvil Fig. 281, Superstrut 452
19	Top beam C-clamp	Anvil Fig. 92, B-Line B3033
20	Side I-beam or channel clamp	Anvil Fig. 14 or 217

Type Number	Description	Manufacturer and Model (or Equal)
21	Center I-beam clamp	Anvil Figure 134
22	Welded attachment type	Anvil Fig. 66 B-Line B3083
23	C-clamp	Anvil Fig. 86, B-Line B3036L
24	U-bolt	Anvil Fig. 137, B-Line B3188
26	Clip	Anvil Fig. 262, B-Line B3180
28	Steel I-beam clamp with eye nut	Anvil Fig. 228
29	Steel wide flange	Anvil Fig. 228 clamp with eye nut
30	Malleable iron beam clamp with extension piece	Superstrut CM-754, B-Line B3054
31	Light welded steel bracket	Anvil Fig. 194, B-Line B3063
32	Medium welded steel bracket	Anvil Fig. 195, B-Line B3066
33	Heavy welded steel bracket	Anvil Fig. 199, B-Line B3067
34	Side beam bracket	Anvil Fig. 202, B-Line B3062
36	Pipe saddle support	Anvil Fig. 258, B-Line B3095
37	Pipe stanchion saddle	Anvil Fig. 259, B-Line B3090
38	Adjustable pipe saddle support	Anvil Fig. 264, B-Line B3093/B3089
39	Steel pipe covering	Anvil Fig. 160, 161, 162, 163, 164, or 165; Superstrut A 789; B-Line B3160/B3165
40	Insulation protection shield	Anvil Fig. 167, B-Line B3151
41	Single pipe roll	Anvil Fig. 171, B-Line B3114
43	Adjustable roller hanger with swivel	Anvil Fig. 181, B-Line B3110
44	Pipe roll, complete	Anvil Fig. 271, B-Line B3117SL

Pipe hangers and supports shall be hot-dipped galvanized according to ASTM A 153/A 153M carbon steel (ASTM A 36/A 36M, ASTM A 575, or ASTM A 576

). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A 48/A 48M). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A 47/A 47M).

2.1.2.26 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.1.2.27 Polyethylene Bagging

Polyethylene bagging for buried ductile iron pipe, fittings, and valves shall be 8 mils thickness minimum polyethylene. The installation of polyethylene bagging shall be in accordance with AWWA C105/A21.5.

2.1.2.27.1 Polyethylene Bagging for DI HDD Applications

The initial piece of pipe will require that the polyethylene bagging be securely attached to the pipe barrel, approximately 1 foot from the end of the pipe, using several circumferential wraps of tape. To prevent drilling fluid or cuttings to get under the polyethylene, the tape should be applied directly to both the polyethylene and metal barrel of the pipe. To prevent drilling fluid and cuttings from being forced under the polyethylene bagging during the pull-back, when applying the polyethylene bagging to the assembled joint, the polyethylene overlap should always have the forward pipe's polyethylene bagging overlap the next pipe's polyethylene. To secure the polyethylene at the joint area, a plastic tie strap or tape should be snugly installed/circumferentially wrapped on each side of the joint.

2.1.2.28 Line Stop Sleeves

Line stop sleeves shall be the high strength type having a wide body, made of a minimum of ASTM A283/A283M Grade C, 285 Grade C Steel, ASTM A 36/A 36M or equal, which conforms to and reinforces the pipe. The sleeves shall have as a minimum 7/8-inch-wide recessed Buna-N gasket around the outlet, 3/4-inch corrosion resistant alloy bolts (in accordance with AWWA C111/A21.11, ANSI A21.11), a 3/4-inch forged steel test outlet and hydrostatic test pressure capability of 200 psi in 12-inch and smaller outlet sizes. Flanged outlet shall be ANSI 150-pound AWWA C207 Class D and shall be indexed in accordance with MSS SP-60. Furnish JCM 440 line stop sleeve with corrosion resistant shop coat paint primer with epoxy coating. Furnish sleeves with a 3/4-inch stainless steel Type 304 plug in the test outlet and optional stainless steel 18-8 Type 304 bolts.

2.1.2.29 Automated Flushing Valves

2.1.2.29.1 Automatic Water Distribution Flushing System Components

The automatic water distribution flushing system is comprised of an automatic flushing unit constructed of brass piping and a brass adjustable 2-inch control valve with dechlorination capabilities and an integrated programmer. The device must also be protected against the environment and vandalism by a non-corrosive, polyethylene enclosure.

2.1.2.29.2 Automatic Flushing Unit

The automatic flushing unit shall be a single unit consisting of the major components described below:

a. Integral Piping and Control Valve:

The piping and control valve components shall include the following:

1. The control valve shall be a globe valve type design capable of passing sand and other debris up to 5/8-inch in diameter without obstructing the valve's throat.

2. Pressure rating: 200 psi.

3. Solid brass construction.

4. Slow closing. No water hammer, surge or noise.

5. Manual operation in the event of power failure with a solid brass heavy duty drain cock.

6. Cross handle flow control (standard).

7. Self-cleaning orifice.

8. Diaphragm of one-piece molded construction with integral O-ring seal reinforced with 600-pound test fabric.

9. The unit's standard internal piping shall be constructed of brass.

10. The unit's internal piping and control valve shall have an operational rating of 200 psi.

b. Protective Enclosure

The self-contained unit shall be supplied with a below-grade base to provide stability and anti-buoyancy capabilities. The base shall be constructed of HDPE or other non-corrosive, high quality, polyethylene material.

The enclosure is to be vented to have a minimum inside width of 17 inches, a minimum inside above grade height of 17 inches, a minimum inside length of 30 inches, and must have a below grade base offering a minimum bury depth of 9 inches.

The unit's above-grade components shall be constructed of a non-corrosive maintenance-free material and shall be permanently colored light green. The material shall be specifically designed for direct exposure to the sun and weather and have a minimum life expectancy of 15 years.

All mounting brackets and hardware shall be stainless steel.

The enclosure shall be Charles Industries Ltd., LLPH Series or approved equal.

c. Backflow Prevention

The self-contained unit shall be supplied with an RPZ for the purpose of backflow prevention in order to prevent discharged water from being reintroduced into the potable water main.

d. Sampling System

The sampling system shall include the following features:

1. The sampling system shall be constructed of stainless steel or other material with equal or greater resistance to bacterial regrowth and be connected with brass fittings.

2. The sampling system shall be design in such a way to reduce the potential for sampling system contamination by allowing access and inspection of the internal piping compartment and components without disassembly or depressurization of the sampling system.

3. Connection to the unit's sampling system shall be by means of a quick-disconnect. The unit's sampling connection shall be housed in a secure weathertight area to minimize contamination of the sampling connection. The sampling connection itself shall be provided with a protective sanitary cover.

e. Electrical/Electronic System

The electrical/electronic system shall include the following features and capabilities:

1. Be capable of storing instructions via an integrated programmer and capable of operating the unit's internal control valve using two replaceable standard Alkaline AA size batteries as a power supply.

2. Offer a minimum nine flushing program events per day.

3. Be leap-year compatible, automatically accounting for February 29th every 4 years.

4. Incorporate LCD readout of clock and programming functions.

5. Offer manual on and off functions.

6. Be secured and water-resistant to a maximum of 6 feet of water.

7. Have heavy-duty power cable.

8. Use an integrated latching solenoid to operate the control valve.

2.1.2.30 Pipe Insulation

Fire hazard rating: Except for materials listed below, all insulation materials, adhesives, coatings, and other accessories shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Excepted are:

1. Urethane insulation for smoke developed only.
2. Asphaltic and coal tar coatings.

2.1.2.30.1 Insulation Performance

Rigid cellular foam urethane with the following requirements:

1. Density: 1.8 to 2.2 pounds per cubic foot.
2. Dimensional stability: 4 percent.
3. Thermal conductivity (BTU in/hr sw. ft. degrees F):
   a. Initial: .11
   b. Design: .14 to .16
   c. Aged: .18
4. Compressive strength: 25 psi with 10 percent deflection.
5. Open cell content: 10 percent or less by volume.
6. Temperature range: 30 degrees F to 220 degrees F.

2.1.2.30.2 Insulation Requirements

Supply all insulation in curved cylindrical segments.

Fabricate insulation in contact with the pipe to suit pipe outside dimensions.

Insulation thickness shall be 1-1/2 inches thick.

Acceptable manufacturers:

1. Owens Corning.
2. CPR Upjohn.
3. Or approved equal.

2.1.2.30.3 Insulation Adhesives, Sealants, and Coatings

Adhesives, sealants, and coatings shall be compatible with materials to which they are applied and shall not corrode, soften, or otherwise attack insulation in any manner. Materials shall be suitable for intended service.

Suitable for a minus 30 degrees F to 200 degrees F operating service.

Acceptable manufacturers:

1. Childers Products Company.
2. Benjamin Foster Company.
3. Lion Oil Company.
4. Or approved equal.

Adhere insulation to piping with suitable adhesive.

Seal all exposed edges of insulation with two coats of suitable flexible sealer.

Seal lap, butt, and longitudinal joints in insulation with one coat of flexible sealer or adhesive.

2.1.2.30.4 Insulation Protective Coverings

Exposed outside piping: Protect insulation with a 0.016-inch-thick corrugated aluminum jacket. Aluminum shall be Type 3003 or 5005, ASTM B 209, Temper H14. Exterior shall have a factory-applied baked-on acrylic coating. The inside of the covering shall have a factory-applied moisture barrier of polyethylene film on Kraft Paper. Covering shall be as manufactured by Childers, Insul-Coustic, or approved equal.

2.1.2.31 Static Mixers

General:

a. Each static mixer shall incorporate tabular mixing arrays, which shall include high-efficiency mixing vortices.

b. Each static mixer shall achieve 95 percent uniform mixing within a distance of three pipe diameters from the last element in each mixer.

c. Each static mixer shall incorporate the required number of tabular arrays to provide complete mixing at all design conditions.

d. Each static mixer shall incorporate mixing arrays of sufficient thickness and flexural rigidity to withstand the hydrodynamic forces of the process flow and the design pressures.

e. Renewable parts shall not be of a lower quality than specified below.

f. Mixer elements shall be continuously sealed to the pipe walls.

g. Mixer ends shall be Class 150 flanged ends flat faced and drilled in accordance with ASME B16.5. Flange facing shall be in accordance with AWWA C115/A21.15. The ends will be connected to ASME B16.1 Class 125 cast iron flanges.

h. The inner diameter of the static mixers shall be the same size as the inner diameter of the adjoining pipes.

i. The projected area of the mixing elements, in the plane perpendicular to the mainstream flow, cannot exceed one-sixth of the total cross-sectional area.

j. At no point may any components of an individual element or adjacent elements intersect or come in direct contact with one another.

Stainless steel:

a. The 16-inch stainless steel static mixer and associated appurtenances shall comply with the criteria in Table 1 and these specifications.

TABLE 1 CRITERIA FOR 16-INCH DIAMETER STAINLESS STEEL STATIC MIXER

Item/Design Conditions	Criteria
Mixer Type	Static, in-line type, with no moving parts
Mixer Description	Each static mixer shall be flanged ends, flange gaskets, and Type 316 SS flange nuts and bolts for connection to adjacent flanged piping
Model*	16 HEV-6

TABLE 1 CRITERIA FOR 16-INCH DIAMETER STAINLESS STEEL STATIC MIXER

Item/Design Conditions	Criteria
Materials of Construction	SS 316
Number of Elements	6
Capacity	300 GPM minimum flow rate 2,500 GPM maximum flow rate
Pressure Rating	100 psig (Design Working Pressure) 200 psig (Design Total Pressure - Working Plus Surge)
Head Loss	Less than or equal to psi/unit at 3,500 GPM
Number of Injector Nozzles per Unit	2 injection nozzles with flanged connections (size and locations as shown on the drawings)
Chemical Injection Flow Rate	1.1 GPH maximum, 0.003 GPH minimum
Number of Units	1
Operation	Continuous

* Chemineer-Kenics model number of equivalent

b. Each mixing element shall be attached directly to the housing wall and cannot rely on adjacent elements, rods, retaining gates, fasteners, or any other device for retention within the mixer.

c. The static mixers shall incorporate materials, construction, and workmanship equal to or in excess of that required by ASTM A 240/A 240M.

Approved manufacturers:

a. The static mixers shall be manufactured by:

1. Chemineer-Kenics, Inc.; Dayton, Ohio.
2. or approved equal.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Copper Tube and Fittings

Copper tubing shall meet the requirements of Federal Specification WW-T 7996 and shall conform to ASTM B 75, ASTM B 88, and ASTM B 68 as they apply to Type K Copper Tubing. Rolled copper tubing is acceptable provided the Contractor installs the tubing without kinking.

2.2.2 Water Service Line Appurtenances

2.2.2.1 Service Saddles

Service saddles shall be epoxy coated ductile iron bodied suitable for use with PVC water main and corporation cocks specified. Saddles shall be double strap design complete with cemented-in-place O-Ring gaskets and full length threaded boss. Saddles shall have stainless-steel type straps; Clamping arrangement which is not fully contoured to the outside diameter of the pipe, or lugs which dig into the pipe or a saddle which distorts the pipe are not acceptable. Saddles shall be rated for leak free operation at a minimum of 200 psi and shall be as manufactured by Mueller Co, or approved equal.

2.2.2.2 Corporation

Corporation (through 2-1/2 inches in diameter) shall be manufactured from cast bronze with machined fitting surfaces and in accordance with AWWA C800. Corporation shall withstand a minimum working pressure of 200 psi. The inlet and outlet connections shall be coordinated to connect to the adjoining equipment, tubing, piping, couplings, unions, adapters, reducers, etc. by the Contractor. The inlet and outlet size shall be the same. The corporation outlet shall have the required all-bronze adapters, unions, reducers, bushings, or couplings to properly secure to the adjacent items and appurtenances. Corporation shall be Model FB series as manufactured by Ford Meter Box Company, Inc., or approved equal. Each corporation shall be furnished with a solid bronze square-head plug for plugging the corporation outlet. Ford stainless-steel insert stiffeners shall be used as required for connection to tubing, PVC pipe, HDPE pipe, or as required.

2.2.2.3 Curb or Service Stops

Curb stops shall be manufactured from cast bronze with machined fitting surfaces. Curb stops shall withstand a minimum working pressure of 150 psi. For curb stops (through 2 inches in diameter), the inlet and outlet connections shall be threaded or have 2-hole flanges to connect to the adjoining equipment, tubing, piping, couplings, unions, adapters, reducers, etc. as coordinated by the Contractor. The nuts and bolts for the flanges shall be cadmium-coated or zinc-plated. The inlet and outlet size shall be the same diameter, unless otherwise approved by the Contracting Officer. The curb stop inlet and outlet shall have the required all-bronze adapters, unions, bushings, or couplings to properly secure it to the adjacent items and appurtenances. Curb stops shall have padlock wings and be lockable with standard size padlocks. Curb stops shall be as manufactured by Ford Meter Box Company, Inc., or approved equal. Each curb stop shall be furnished with a solid bronze square-head plug for plugging the curb stop outlet. For stainless steel, insert stiffeners shall be used as required for connection to tubing, PVC pipe, HDPE pipe, or as required.

2.2.2.4 Curb Boxes

Provide a curb box for each curb or service stop. Curb boxes shall be of cast iron of a size suitable for the stop on which it is to be used. Provide a round head. Cast the word "WATER" on the lid. Each box shall have a heavy coat of bituminous paint.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

3.1.1.1 Cutting Of Pipe

Cutting of pipe shall be done without damage to the pipe. Cutting shall be done with an approved mechanical cutter. Wheel cutters shall be used when practical.

3.1.1.2 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the drawings.

3.1.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.4 Placing, Laying And Pipe Connections

Pipe and accessories shall be carefully lowered into the trench by suitable equipment. Under no circumstances shall materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers for removing skids across trenches shall be made of wood and have broad flat faces to prevent damage to the pipe or coating. Except where necessary in making connections with other lines or as authorized, pipe shall be laid with the bells facing upstream. Full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that foreign material will not enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor in an approved manner, at no additional expense to the Government.

Pipe ends left for future connections shall be valved, plugged, or capped and anchored. Where connections are made between new work and existing mains, the connections shall be made by using special sections and fittings to suit the actual conditions. Where made under pressure, connections shall be installed in accordance with the recommendations of the manufacturer of the pipe being tapped.

3.1.1.5 Rubber Gaskets

Rubber gaskets shall be handled, lubricated, and installed in accordance with the pipe manufacturer's recommendations.

3.1.1.6 Couplings And Joints

Installation of couplings, mechanical joints, and flanged joints shall be in accordance with the manufacturer's recommendations. Pipe Connections between different types of pipe and accessories shall be made with transition fittings as recommended by the manufacturer.

3.1.1.7 Deflection

Maximum allowable deflection for ductile iron bell-and-spigot pipe and mechanical-joint pipe, shall be as recommended by the manufacturer.

When the alignment requires deflections in excess of the manufacturer's recommendations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflections does not exceed the maximum recommended by the pipe manufacturer. Short-radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated special sections.

3.1.1.8 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.1.9 Anchoring and Restraining

Refer to drawings for thrust block requirements.

3.1.1.10 Locating Devices

Locating devices shall be located as indicated in the contract documents. For all subsurface fittings with thrust blocks, embed the device into the top surface on the thrust block such that half the device is exposed and the location is at the centroid of the thrust block top surface area. For all subsurface elbows, tees, and valves without thrust blocks installed, install the device 6 inches above the fitting unless noted otherwise. The locating devices shall be Omni Marker Model 161 Water Marker or approved equal. Locating devices shall not be installed at vertical bends.

3.1.1.11 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3.1.1.12 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.1.13 HDPE Pipe and Fittings

3.1.1.13.1 General

All polyethylene pipe shall be cut, fabricated, joined, and installed in strict conformance with the pipe manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with HDPE pipe.

3.1.1.13.2 Laying Pipe

Joints

All HDPE to HDPE pipe joints shall be joined by heat fusion that produces homogeneous, sealed, leak-tight joints.

Restrained mechanical joint adaptors shall be provided at tie-ins with valves, ductile iron fittings, and other pipe materials.

Butt Fusion Testing

The Contractor shall test the first fusion of each day.

In testing, the fusion shall be allowed to cool completely and then fusion test straps shall be cut out. The test shall be a minimum of 12 inches or 30 times the wall thickness in length with the fusion in the center and a minimum of 1 inch or 1.5 times the wall thickness in width. Bend the test strap until the ends of the strap touch. The Contractor shall not begin until a fusion test has passed the bent strap test.

Pipe Deflection

When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane or where long radius curves are permitted, the amount of deflection shall not exceed 75% of that recommended by the manufacturer.

Pipe Cutting

Cutting HDPE butt fusion connections to HDPE pipe, valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without damaging the pipe. Ends shall be cut square and perpendicular to the pipe axis.

3.1.1.14 Line Stops for Outages

The Contractor shall have line stop installation crews available at the beginning of each outage to install all line stops as directed by the Contracting Officer. The Contractor's crew shall be certified by the manufacturer for the installation of line stops or the Contractor shall have a certified manufacturer's representative onsite to supervise the installation.

3.1.1.15 Stainless Steel Pipe and Fittings

3.1.1.15.1 Fabrication, Assembly, and Erection

Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding. When welding the reverse side, chip out slag before welding.

Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME Boiler and Pressure Vessel Code.

The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	Minimum Number of Passes for Welds
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full penetration.

Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

Welding preparation shall comply with ASME B31.3, Paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2, and Paragraph 341.4 for visual examination.

Identify welds in accordance with ASME B31.3, Paragraph 328.5.

Clean each layer of deposited weld metal before depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas before the root pass.

Welded butt joints (both longitudinal and circumferential) shall comply with AWWA C220, Section 4. Do not use backing rings. Provide full penetration and smooth internal diameters for the root bead of welds. Grind the inside weld of socket welds flush with the pipe internal diameter. Welds shall be of smooth finish. Use anti-spatter compounds specifically formulated or designed for use with stainless steel. Do not allow heat tint to form in the heat-affected zone or remove heat tint completely from the heat-affected zone of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10 percent of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.

No iron or steel surfaces shall come into contact with the stainless steel. This includes placing the stainless steel on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

Welding electrodes shall comply with AWS A5.4/A5.4M. Bare wire shall comply with AWS A5.9/A5.9M. Use electrodes as follows:

Pipe Material	Welding Electrode Material
Type 304	E 308
Type 304L	E 347
Type 316	E 316
Type 316L	E 318

3.1.1.15.2 Shop Testing of Fabricated or Welded Material

After completion of fabrication and welding in the shop and before the application of any lining or coating, test each component according to the referenced standards. Test fabricated fittings as specified in AWWA C200. Test the seams in fittings that have not been previously shop hydrostatically tested by the dye penetrant method as described in ASME BPVC SEC VIII, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125 percent of the design pressure, whichever is higher.

3.1.1.15.3 Installing Buried Piping

Install in accordance with Section 31 00 00, EARTHWORK, and as follows.

When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

3.1.1.15.4 Field Hydrostatic Testing

The Contractor shall hydrostatically test pipe and fittings in the field in accordance with paragraph entitled "TESTING--NON-HDPE PIPE AND FITTINGS" of this section.

Do not allow test water to remain in the pipe for more than 5 days. Drain and dry the piping after completing the testing.

3.1.1.15.5 Painting and Coating

Do not coat buried stainless steel piping.

3.1.1.16 Copper Piping--Joint Construction

Soldered Joints: Use ASTM A 813/A 813M, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated.

3.1.2 Installation of Automated Flushing Valves

Remove rock or other debris that might create uneven pressure on the unit from the bottom of the hole. Compact the bottom of the hole to minimize settling after installation.

Install a 4-inch lift of non-compacted sand or similar bedding material into the bottom of the hole.

Backfill the hole around the automatic flushing valve with a combination of #57 stone and clean fill, free of rock or other debris. Backfilling shall be accomplished in 6-inch lifts. Use a level to ensure the unit is level after each lift.

The automatic flushing valve shall be disinfected in accordance with ADH and AWWA standards.

3.1.3 Installation of Valves and Hydrants

a. Installation of Valves: Installation of valves shall be in accordance with manufacturer's recommendations.

b. Installation of Hydrants: Installation of hydrants shall be in accordance with manufacturer's recommendations. Install hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, contact the Contracting Officer for further instructions.

3.1.4 Installation of Pipe Insulation

All insulation work shall be executed by skilled insulation workmen regularly employed in the trade.

All insulation shall be applied in strict accordance with these Specifications and with factory-printed recommendations on items not mentioned in this Section. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of 3 years experience specializing in the trade.

Do not apply insulation until all surfaces to be covered are tested for leaks and approved, cleaned, dried, and all foreign material such as rust, scale, dirt, etc., has been removed.

Clean and dry insulation when installing and during the application of any finish.

Do not install insulation when temperature is less than 45 degrees F.

Insulate fittings and flanges with sections fabricated from standard insulation sections, rigid urethane boards or blocks, or a combination of both.

Fit insulation to eliminate voids. Seal all joints.

For heat-traced piping, insulate fittings, joints, and valves with insulation compatible with the heating cables and associated equipment. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams on the bottom side of horizontal piping.

3.1.4.1 Exposed Outside Piping

Install aluminum covering only after the insulation application has been inspected and approved by the Contracting Officer.

Seal lap-type covering systems on butt and longitudinal seams. Overlap shall be 2 inches minimum on side and edge laps with longitudinal cut edge turned under to provide a smooth edge.

Seal lock joint systems on longitudinal and butt or end seams.

Position all horizontal joints to shed water.

Fasten aluminum covering with 1/2-inch-wide-by-0.105-inch-thick stainless steel bands installed on 9-inch center.

3.1.5 Installation of Water Service Piping

3.1.5.1 Service Line Connections to Water Mains

Connect service lines 2 inch size to the main by a corporation stop and gooseneck and install a service stop below the frostline as indicated. Connect service lines to ductile-iron water mains in accordance with AWWA C600 for service taps. Connect service lines to PVC water mains in accordance with AWWA C605 for service taps.

3.1.6 Installation of Transition Coupling--HDPE to Stainless Steel

Install transition coupling per manufacturer's requirements and recommendations.

3.2 TESTING -- NON-HDPE PIPE AND FITTINGS

3.2.1 Hydrostatic Test of Above ground or Exposed Piping

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

Subject the piping system to the test pressure of 150 psi. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.2.2 Leakage Test for Buried Piping

Leakage tests shall be conducted concurrently with the pressure test. Duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 150 psi. Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula:

DUCTILE IRON PIPE		**PVC PIPE**	
$L = \frac{SD(P)^{1/2}}{C}$		$L = \frac{ND(P)^{1/2}}{C}$	
in which:		in which:	
L = allowable leakage (gallons)		L = allowable leakage (gallons)	
S = length of pipe tested (feet)		N = number of rubber-gasketed joints in the pipe tested	
D = diameter of the pipe (inches)		D = diameter of the pipe (inches)	
P = specified test pressure (psig)		P = specified test pressure (psig)	
C = 133,200		C = 7,400	

Should any test of laid pipe disclose a leakage greater than that shown, the defective joints shall be located and repaired until the leakage is within the specified tolerance, at no additional cost to the Government.

3.2.3 Test Timing

Except where concrete-reaction backing necessitates a 72-hour delay, pipelines jointed with rubber gaskets, mechanical, or bolted joints may be subjected to hydrostatic pressure, inspected, and tested for leakage after partial completion of backfill.

3.2.4 Retesting

Before permanent paving is placed over the pipeline, a measured leakage test of the entire pipeline shall be required. Leakage loss shall be within approved tolerances.

3.2.5 Sterilizing

Water piping, including valves, fittings, and other devices, shall be sterilized and tested according to AWWA C651. After successful sterilization, the piping shall be flushed before placing into service. Water for sterilization will be furnished by the Government, but disposal shall be the responsibility of the Contractor.

3.3 TESTING -- HDPE PIPE AND FITTINGS

Hydrostatic Tests-General

All field tests shall be made in the presence of the Government or Contracting Officer. Except as otherwise directed, all pipelines shall be tested. All piping to operate under liquid pressure shall be tested in sections of approved length, typically from valve to valve and in no case longer than 1,000 feet.

Hydrostatic testing shall consist of a 150 psi combined pressure test and leakage test. The field test pressure shall be measured at the lowest point of the section being tested. The pressure shall be applied by a pump connected to the pipe in a manner satisfactory to the Contracting Officer. The pump, pipe connection, and all necessary apparatus shall be furnished by the Contractor and shall be subject to the satisfaction of the Contracting Officer.

The maximum duration for any test, including initial pressurization, initial expansion, and time at test pressure, must not exceed 8 hours. If the test is not completed due to leakage, equipment failure, etc., depressurize the test section and allow it to "relax" for at least 8 hours before bringing the test section up to test pressure again.

Monitored Make-Up Water Test: The test procedure consists of initial expansion and test phases.

During the initial expansion phase, the test section is filled with water. Once the line is filled, make-up water is added at hourly intervals as required to maintain the test pressure for 3 hours.

At the end of the initial expansion period, the addition of make-up water will cease. During the test phase the pipe will not have any water added to it for the following 2 hours. The 2 hours will be the actual leakage test. At the end of the 2-hour period, measured make-up water will be added to the pipe to return it to the original test pressure.

If the amount of make-up water added is greater than calculated using the numbers listed below, the section being tested will be considered to have a leak. The leak shall be found and fixed at the Contractor's expense and that section of the line retested before continuing with subsequent leakage tests. Testing and repairs shall be repeated at the Contractor's expense until the amount of make-up water is less than the amount calculated using the numbers listed below.

ALLOWABLE FOR EXPANSION UNDER TEST PRESSURE* POLYETHYLENE PIPE			
Nominal Pipe Size (inches)	Allowances for Expansion		
	1-Hour Test	2-Hour Test	3-Hour Test
2	0.08	0.12	0.15
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90

These allowances only apply to the test phase and not to the initial expansion phase.

3.4 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow preventer assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.5 WATER MAIN TAPS/SADDLES

The existing distribution system shall be protected from backflow contamination during filling for pressure testing, flushing, disinfection, and final connections in accordance with AWWA C651. A 2 inch jumped connection bypassing the tie-in valve with an approved double-check valve or approved backflow prevention device shall be used for filling the new water main. The tie-in valve shall be closed and secured by a locking mechanism until flushing of the new water main occurs.

Prior to installing a service saddle, the KSC Pollution Control and Sanitation Officer (PCSO), or designated representative, must be contacted to monitor the installation. The exterior surface of the main to be tapped shall be thoroughly cleaned. Once the sleeve is securely attached to the main, the sleeve shall be filled with a hypochlorite solution and hydrostatically tested at 200 psi for a minimum of 15 minutes with no loss of pressure or sign of leakage. During the tapping process, the interior surface of the sleeve and the surface being tapped shall be in direct contact with the hypochlorite. After the tapping procedure is complete, flush the line to remove metal bits and debris.

All connections to existing work shall be in accordance with AWWA C651 for protection of existing main from contamination by the new line during filling, flushing and testing.

3.6 DISINFECTION CRITERIA FOR KSC POTABLE WATER SYSTEM INSTALLATION, REPAIR, OR MODIFICATION TO WATER MAINS

The KSC Pollution Control and Sanitation Officer (PCSO) or designated representative shall approve the disinfection procedure to be used and be present during the process. A minimum of 24 hours lead time is required to schedule attendance of disinfection by PCSO or representative. Contact should be made through the Construction Management Office. Ensure proper disinfection protocol/bacteriological sampling occurs if water line is broken, tapped, modified, or if loss of pressure occurs. All repaired, modified or newly installed water system components shall be disinfected after pressure and leak tests have been performed. All existing mains closed for outage shall be disinfected and tested prior to use. The system components to be disinfected shall be thoroughly flushed with potable water before introducing the chlorinating solution. This flushing is required to remove all debris from the systems components. The chlorinating solution shall provide a dosage of not less than 50 parts per million (ppm). The chlorine solution shall be introduced into the water line in an approved manner and be evenly distributed throughout the entire effected systems components long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and tests shall reveal not less than 25 ppm of chlorine residual after the 24 hour retention period. The line shall be flushed with potable water until the residual chlorine level is reduced to less than 1.0 ppm or to the normal background level in the area. Discharge of highly chlorinated water from disinfection shall be coordinated with URS Water and Wastewater. Samples will be collected by the Contractor or designated representative from several points in the water system for bacteriological examination. The system will remain closed and will not be accepted for use until two consecutive days of satisfactory bacteriological results have been obtained and approval has been given by the PCSO and regulatory agencies.

Taps, modification, repairs, or new lines added to the system shall be tested and disinfected following AWWA C651 and KNPR 8500.1. Successful disinfection shall be demonstrated by bacteriological testing following FAC 62-555.340(1) and FAC 62-555.340(2).

Bacteriological testing shall be provided by the Government. The Contractor shall coordinate the scheduling of tests with the Government and take corrective actions if results do not meet required standards.

3.7 DISPOSING OF HEAVILY CHLORINATED WATER

The environment to which chlorinated water may be discharged shall be inspected by the Contractor, and, if there is any question that the chlorinated discharge will cause damage to personnel or the environment, then a reducing agent shall be applied to the water (reference Appendix B of the current AWWA C651 for neutralizing chemicals). Such discharges should be coordinated with the KSC PCSO, or designated representative.

3.8 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

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SANITARY SEWERS

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SECTION 33 30 00

SANITARY SEWERS

PART 1 GENERAL

1.1 RELATED SECTIONS

The provisions of other sections of the General and Supplementary Conditions are fully applicable to this Section as if incorporated herein.

Other related or referenced sections contained herein are as listed below:

Section 03 01 30.71	CONCRETE REHABILITATION
Section 03 30 00	CAST-IN-PLACE CONCRETE
Section 03 40 00.00 10	PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION
Section 09 90 00.00 98	PAINTING AND COATING
Section 31 00 00	EARTHWORK

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI C1012	(2007; Errata 2009) Ductile Iron or Malleable Iron for 1/2-inch thru 1-1/2-inch

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C200	(2005) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C504	(2006; R 2010) Standard for Rubber-Seated Butterfly Valves
AWWA C606	(2006) Grooved and Shouldered Joints
AWWA M11	(2004; 4th Ed) Manual: Steel Water Pipe: A Guide for Design and Installation

ASME INTERNATIONAL (ASME)

ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2005) Gray Iron Threaded Fittings;

	Classes 25, 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2003; R 2008) Machine Screws and Machine Screw Nuts
ASME SA-36	(1998) Steel Designations
ASME SA-675	(1998) Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASME B31.1	(2010) Power Piping
ASME B31.3	(2010) Process Piping
ASME B36.19M	(2004; R 2010) Stainless Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A105M	(2010a) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 181/A181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 182/A 182M	(2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 27/A 27M	(2008) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2011) Standard Specification for

	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A 325	(2009a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 380	(2006) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A 403/A 403M	(2010a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A 489	(2004e1) Standard Specification for Carbon Steel Lifting Eyes
ASTM A 513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 530/A 530M	(2004a; R 2010) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 635/A 635M	(2009b) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for
ASTM A 743/A 743M	(2006) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM D 2564	(2009) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM B 633	(2007) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C 478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2680	(2001) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3034	(2008) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3261	(2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3350	(2010) Polyethylene Plastics Pipe and Fittings Materials
ASTM E 488	(1996; R 2003) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F 1554	(2007a) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F 436	(2010) Standard Specification for Hardened Steel Washers
ASTM F 593	(2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 594	(2009) Standard Specification for Stainless Steel Nuts
ASTM F 656	(2010) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 879	(2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air

AMERICAN WELDING SOCIETY (AWS)

AWS A5.4/A5.4M	(2006) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS A5.9/A5.9M	(2006; Errata 2007) Specification for Bare Stainless Steel Welding Electrodes and Rods

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(2006) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-83	(2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-97	(2006) Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded, and Buttwelding Ends

1.3 SYSTEM DESCRIPTION

1.3.1 Sanitary Sewer Gravity Pipeline

Provide new exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

1.3.2 Sanitary Sewer Pressure Lines

Provide pressure lines of high density polyethylene (HDPE) pipe.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit method of testing in accordance with the paragraph entitled "Gravity Piping."

SD-03 Product Data

Pipeline materials; G
Pipeline Appurtenances; G

Submit manufacturer's standard drawings or catalog cuts.

SD-06 Test Reports

Air Test; G
Hydrostatic Test; G
Leakage Test; G

Reports for the following shall be submitted in accordance with paragraph entitled "Reports" of this section.

Reports; G

Test and inspection reports, as specified.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.5.1.1 Quality Control For Stainless Steel Pipe

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530/A 530M.

Use only certified welders meeting procedures and performance outlined in Section IX of the ASME BPVC and other codes and requirements in accordance with local building and utility requirements. Obtain Welder's certificates for the project record before beginning any welding on the project. The Welder must be certified for all positions (flat, vertical, and overhead).

Have all welds conform to highest industrial practice in accordance with ASME B31.3 and ASME B31.1 or other codes and requirements in accordance with local building and utility requirements.

1.5.2 Drawings

a. Installation drawings shall be submitted showing complete detail, both plan and side view details with proper layout dimensions and elevations.

b. Record drawings for the complete sanitary sewer system shall be submitted showing complete detail with all dimensions, both above and below grade, including invert elevations.

c. Record drawings shall be signed and sealed by a Professional

Surveyor. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

1.6.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.6.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.6.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.6.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Sewer Piping

2.1.1.1 PVC Plastic Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Cell Classification 12454-B DR 35 with push-on joints and shall be green.

2.1.2 PVC Plastic Pressure Pipe and Fittings

2.1.2.1 Pipe

Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and ASTM D 1785.

2.1.2.2 Fittings

Fittings shall be Schedule 80 and shall conform to ASTM D 2464 for threaded fittings and ASTM D 2467 for socket-type fittings.

2.1.2.3 Unions

Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, conforming to ASTM D 1784.

2.1.2.4 Joints

Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to valves and equipment.

2.1.2.5 Solvent Cement

Solvent cement for socket joints shall comply with ASTM D 2564 and ASTM F 656.

2.1.3 HDPE Plastic Pressure Pipe and Fittings

2.1.3.1 General

All HDPE shall be DriscoPlex PE 3408 HDPE or approved equal.

All HDPE pipe 4 inches in diameter or greater shall have a ductile iron pipe outside diameter, and HDPE pipe 3 inches in diameter and smaller shall be IPS unless otherwise specified or drawing in the drawings.

All HDPE piping system components shall be the products of one manufacturer.

Pipe and fittings shall be manufactured by an ISO 9001-certified manufacturer.

2.1.3.2 HDPE Pipe

HDPE pipe 4 inches in diameter and larger shall conform to material standard ASTM D 3350 345435 E cell classification rated as PE 3408 by the Plastic Pipe Institute. Minimum pressure rating shall be in accordance with Piping Schedule Drawing or as specified in this Section. Minimum pressure rating shall be 100 psi SDR 17 (Standard Dimension Ratio) for pipe sizes greater than 4 inches in diameter. For pipe sizes 3 inches and smaller in diameter, the minimum pressure rating shall be 200 psi SDR 9.

The polyethylene compound shall be suitably protected against degradation by ultraviolet light.

The maximum allowable hoop stress shall be 800 psi at 73.4 degrees F.

The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the requirements of the resin manufacturer to manufacture pipe from the resin used.

2.1.3.3 HDPE Pipe Fittings

Use molded or fabricated polyethylene fitting. The polyethylene fittings shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe.

a. Molded Fittings shall be manufactured in accordance with ASTM D 3261 and shall be so marked. Each production lot of molded fittings shall be subject to the test required under ASTM D 3261. The manufacturer shall submit samples from each molded fitting production lot to x-ray inspection for voids and shall certify that voids were not found.

b. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full-service pressure rating of the mating pipe. Pressure de-rated fittings are not acceptable. Directional fittings 16 inches IPS and larger, such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets.

The manufacturer of the HDPE pipe shall supply all DI/HDPE mechanical joint adapters and accessories required to connect plain-end HDPE piping to mechanical joint fittings, valves, and appurtenances.

The DI/HDPE mechanical joint adapter shall consist of:

a. A molded or fabricated HDPE mechanical joint transition fitting.

b. A gasket for a DI mechanical joint.

c. A ductile iron mechanical joint backup drive ring.

d. Mechanical joint tee bolts.

e. A stainless-steel sleeve stiffener molded or fabricated within the MJ end of the HDPE mechanical joint adapter fitting.

The DI/HDPE mechanical joint adapter shall be connected to the HDPE pipe by a heat-fused joint on one end and connected to a ductile iron pipe valve, fitting, or appurtenance with the internally stiffened mechanical joint end.

The tee bolts and backup drive ring shall act as a joint restraint for connections to mechanical joints.

The HDPE mechanical joint adapter fitting shall be molded or fabricated by the manufacturer of the HDPE pipe. All molded fittings shall be fully pressure rated to match the SDR pipe pressure rating. Fabricated fittings shall be rated for internal pressure service equivalent to the full pressure rating of the mated IPS pipe.

If rework compounds are required, only those generated in the manufacture's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.

Solvent epoxy cementing and mechanical joining with bolt on wrap-around clamps shall not be used.

2.1.3.4 HDPE Pipe Jointing Method

HDPE pipe shall be jointed by butt fusion in accordance with the pipe manufacturer's directions and only for pipe within one SDR ratio of each other.

For SDR ratios that are two or more apart (i.e. SDR 21 to an SDR 11), the joint shall be made using a restrained joint. Same-diameter pipe may be joined by using HDPE flange adapters and backup rings bolted to each other.

All HDPE pipe joined by butt fusion shall be made from the same class and type of raw material made by the same raw material supplier.

Butt fusion means the butt joining of the pipe by heat fusion aligned faces of the pipe ends (butts) in a suitable apparatus and joining under controlled pressure and alignment.

The external bead resulting from the butt fusion process shall be visible and examined for complete butt fusion 360 degrees around the pipe exterior.

Short spools of pipe between valves and fittings shall be ductile iron pipe, with all joints restrained for sizes 4 inches and larger. For 2-inch, the spool shall be Schedule 40 Type 304 stainless steel piping with IP threads stainless steel.

Where approved by the Contracting Officer, the HDPE pipe and fittings may be fused with Electrofusion Couplings, as manufactured by Central Plastics Company, or approved equal. Technical information must be provided to demonstrate that the fused coupling will not compromise the structural integrity of the HDPE pipe.

2.1.4 Stainless Steel Pipe and Fittings

2.1.4.1 Stainless Steel Pipe

Pipe smaller than 3 inches shall conform to ASTM A 312/A 312M, Grade TP 304L. Pipe 3 inches and larger shall conform to ASTM A 312/A 312M, Grade TP 304L.

Pipe sizes and wall thicknesses shall conform to ASME B36.19M as follows:

Pipe Size	Wall Thickness
1-1/4 inches through 3 inches	Schedule 80S

2.1.4.2 Fittings

Fittings 3 inches and smaller shall be socket welded, conforming to ASME B16.11, 3,000-pound CWP. Material for socket-welded fittings shall conform to ASTM A 403/A 403M, Class WP 304L or ASTM A 182/A 182M, Grade F304L.

2.1.4.3 Preparation and Final Cleaning

Pipe and fittings shall be final cleaned, pickled, and passivated in accordance with ASTM A 380. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of the stainless steel by a chemical dissolution, a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean if there is any evidence of rusting.

2.1.4.4 Protective End Caps

The Contractor shall provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

2.1.4.5 Unions

Unions shall be 3,000-pound WOG-forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be socket-welded type. Material shall conform to ASTM A 182/A 182M, Grade F304L for socket-welded type.

2.1.4.6 Joints

Joints for pipes 3 inches and smaller shall be socket welded, the same material as specified for fittings, 3,000-pound WOG, conforming to ASME B16.11.

Provide plain-end pipe where flexible pipe couplings are to be provided. Provide lugs for thrust harnesses in accordance with the paragraph titled "Fittings."

Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.1.4.7 Outlets and Nozzles

Outlets of 3 inches and smaller in piping 4 inches and larger shall be of the Thredolet type, in accordance with MSS SP-97 and AWWA M11, Figure 13-23. Outlets shall be 3,000-pound WOG stainless steel in accordance with ASTM A 182/A 182M, Grade F304L F316L or ASTM A 403/A 403M, Grade WP304L WP316L. Threads shall comply with ASME B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

Alternatively, threaded openings not less than 2 inches or more than 3 inches in nominal size shall be a flat-bottom half-coupling conforming to ASME B16.11, Class 3000. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted. Forge the threaded outlet and its plug from steel conforming to ASTM A 105/A105M or ASTM A 181/A181M, Class 70.

For outlets 3 inches and smaller in piping smaller than 4 inches, use a tee with a threaded outlet.

For outlets larger than 3 inches, use a tee with a flanged outlet.

2.1.4.8 Groove-End Couplings

Grooved-end couplings for piping 24 inches and smaller shall be Type 316 stainless steel. Couplings shall be flexible type, square-cut grooved, in accordance with AWWA C606. Couplings shall be Victaulic Style 77-S, Gustin-Bacon Figure 100, or equal.

Gaskets shall be EPDM and shall conform to ASTM D 2000.

Bolts in exposed service shall conform to stainless steel. Bolts in buried or submerged service shall be stainless steel.

Couplings for connecting to grooved-end valves shall be Victaulic Style 75 to match the valve ends.

Grooved-end adapter flanges for pipe 18 inches and smaller having a maximum test pressure of 200 psi shall comply with ASME B16.1, Class 125 dimensions. Flanges shall be Victaulic Style 741 or 742, Gustin-Bacon Figure 154, or equal.

2.1.4.9 Lubricant for Stainless Steel Bolts and Nuts

Anti-seize thread lubricant shall be applied to the thread portion of all (above grade and below grade) stainless steel bolts (stainless steel tie rods, etc.) during assembly. Anti-seize lubricant shall be chloride free and shall be nongalling NSF approved. Anti-seize thread lubricant shall be Jet-Lube "Nikal," John Crane "Thred Gard Nickel," Never-Seez "Pure Nickel Special," or Permatex "Nickel Anti-Seize."

2.1.5 Ductile Iron Pipe

Ductile iron piping and appurtenances shall conform to the ductile iron pipe section in Section 33 11 00 WATER DISTRIBUTION with protective 401 lining or approved equal instead of cement lining and shall be painted green.

2.1.6 Pipeline Appurtenances

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless-steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

13. Cast-in Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized in accordance with ASTM A 153/A 153M.

14. Expansion Anchors: Anchor bolt and sleeve assembly with the ability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

b. Material for Anchors in Exterior Locations: Alloy Group (A4) stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.1.7 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675GR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.2 VALVES

2.2.1 Plug Valve

Conform plug valves to MSS SP-70.

Ensure that all plug valves are eccentric plug valves unless otherwise specified.

Plug valves shall be of the nonlubricated rectangular ported eccentric type with resilient faced plugs. Furnish valves in vaults or above-grade with flanged end connections. Furnish buried valves with mechanical joint end connections. Face and drill flanged valves to the ANSI 125/150-pound standard. Mechanical joint ends shall conform with AWWA C111/A21.11, grooved ends shall conform with AWWA C606. Screwed ends shall conform to the NPT standard.

Valve bodies shall be made of Class B cast iron conforming to ASTM A 126.

Furnish bodies in 4-inch and larger valves with a 1/8 inch welded overlay seat of not less than 90 percent pure nickel. Seat area shall be raised with raised surface completely covered with weld to ensure that the plug face contacts only nickel. Screwed-in seats are not acceptable.

Plugs shall be cast iron conforming to ASTM A 126 Class B. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat with the plug in the closed position shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be chloroprene (CR) or resilient facing suitable for application. VE option of round port valves is not acceptable.

Bearings shall have sleeve type metal bearings and shall be of sintered, soil impregnated permanently lubricated Type 316 ASTM A 743/A 743M Grade CF-8M. Non metallic bearings are not acceptable.

Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Valves using O-ring seals or non-adjustable packing are not acceptable. All exposed nuts, bolts, springs, washers, and other fasteners shall be 300-series stainless steel.

Pressure ratings shall be 175 psi. Test every valve with a hydrostatic and seat test and furnish certified copies of proof-of-design test reports as outlined in AWWA C504, Section 5.5.

Unless noted otherwise, equip manual valves with the following actuators:

Exposed valves 4 inches: removable lever actuators.

Equip all valves 6 inches and larger with worm-gear type actuators. Geared actuators shall be worm-gear type. Geared actuators and mounting brackets shall be designed for buried and submerged service and shall be totally enclosed in a cast iron housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. Support the actuator shaft and the quadrant on permanently lubricated bronze bearings.

Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide adjustment to compensate for change in pressure differential or flow direction change.

Ensure that valves and gear actuators for buried or submerged service have seals on all shaft and gaskets on the valve and actuator covers to prevent the entry of water. Totally enclose actuator mounting brackets for buried or submerged service and provide gasket seals.

All actuators shall be furnished by the valve manufacturer and shall be factory assembled, adjusted, and tested with the valve. Test reports shall be available upon request.

The exterior of valves and actuators shall be factory prepared and primed, and field finish coated in accordance with Section 09 90 00.00 98 PAINTING AND COATING. Buried valves shall be polyethylene encased as specified herein for ductile iron pipe and fittings.

Plug valves shall be DeZURIK PEC or approved equal.

2.2.2 Air Release Valves

Use air release valves designed to permit release of air from an empty pipe during filling and capable of discharging accumulated air in the line while the line is in operation and under pressure. Attach valves with threaded pipe connections. Ensure that valves are vented to the atmosphere.

2.2.2.1 Combination Valve

Automatic combination valves shall be capable of withstanding operating pressures of 150 psi. The valves shall have a threaded outlet. The body and cover of the valve shall be made of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve. The valve shall be the Valmatic Combination Air Valve Series 800S or approved equal.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Precast Concrete Manholes

Precast concrete manhole risers, base sections, and tops shall conform to ASTM C 478 and be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser shall be monolithic.

2.3.2 Transition Coupling--HDPE to Stainless Steel

Refer to paragraph entitled "Transition Coupling--HDPE to Stainless Steel" of Section 33 11 00, WATER DISTRIBUTION.

2.3.3 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.4 REPORTS

Submit Test Reports. Compaction and density test shall be in accordance with Section 31 00 00 EARTHWORK. Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear feet.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.1.1 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the Drawings.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Bottom of trench shall be shaped to give uniform circumferential support to the lower fourth of each pipe. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in a manner to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Interior of the sewer shall be cleared of superfluous materials at all times. Where cleaning after laying is difficult, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. When the maximum width of the trench at the top of the pipe is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, such bedding as may be required to satisfactorily support the added load of the backfill. Trenches shall be kept free from water until the pipe-joining material has set. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. When work is not in progress, open ends of pipe and fittings shall be closed to prevent intrusion of foreign materials.

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

3.1.1.4 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.1.1.5 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.2 Special Requirements

3.1.2.1 Installation of HDPE Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with requirements of ASTM F 714.

3.1.2.2 Solvent-Welded Joints

Before solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least 1 hour.

Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.

Make up solvent-welded joints in accordance with ASTM D 2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

Allow at least 8 hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

Acceptance criteria for solvent-welded joints shall be as follows:

Unfilled Areas in Joint: None permitted.

Unbonded Areas in Joint: None permitted.

Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50 percent.

3.1.2.3 Stainless Steel Pipe

3.1.2.3.1 Fabrication, Assembly, And Erection

Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of ASME BPVC.

The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	Minimum Number of Passes for Welds
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full penetration.

Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

Welding preparation shall comply with ASME B31.3, Paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2, and Paragraph 341.4 for visual examination.

Identify welds in accordance with ASME B31.3, Paragraph 328.5.

Clean each layer of deposited weld metal before depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas before the root pass.

Provide full penetration and smooth internal diameters for the root bead of welds. Grind the inside weld of socket welds flush with the pipe internal diameter. Welds shall be of smooth finish. Use anti-spatter compounds specifically formulated or designed for use with stainless steel. Do not allow heat tint to form in the heat-affected zone or remove heat tint completely from the heat-affected zone of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10 percent of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.

No iron or steel surfaces shall come into contact with the stainless steel. This includes placing the stainless steel on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

Welding electrodes shall comply with AWS A5.4/A5.4M. Bare wire shall comply with AWS A5.9/A5.9M. Use electrodes as follows:

Pipe Material	Welding Electrode Material
Type 304	E 308
Type 304L	E 347
Type 316	E 316
Type 316L	E 318

3.1.2.3.2 Shop Testing Of Fabricated Or Welded Components

After completion of fabrication and welding in the shop and before the application of any lining or coating, test each component according to the referenced standards. Test fabricated fittings as specified in AWWA C200. Test the seams in fittings that have not been previously shop hydrostatically tested by the dye penetrant method as described in Section VII of ASME BPVC, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125 percent of the design pressure, whichever is higher.

3.1.2.3.3 Installation Of Stainless Steel Bolts And Nuts

Coat threaded portions of stainless steel bolts and nuts with lubricant before assembly.

3.1.2.3.4 Painting And Coating

Do not coat stainless steel grooved-end couplings and Van Stone flanges.

Do not coat buried stainless steel piping, bolts, nuts, or tie rods.

3.1.3 Installation of Transition Coupling--HDPE to Stainless Steel

Refer to paragraph entitled "Installation of Transition Coupling--HDPE to Stainless Steel" of Section 33 11 00, WATER DISTRIBUTION.

3.1.4 Miscellaneous Construction and Installation

3.1.4.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.2 INSPECTION AND TESTING

3.2.1 General

Inspect all work constructed for faults or defects and correct any deviation from these documents or omissions at once. Conduct all tests and provide necessary equipment and personnel for lamping the system in the presence of the Contracting Officer. The Contractor shall bear all costs for these tests and inspections.

Test sewers by a low-pressure air test.

Ensure that pipe testing closely follows pipe laying. No more than 1,000 feet of pipe shall remain untested at any time.

3.2.2 Gravity Piping

Submit the proposed method of testing to the Contracting Officer for approval. Perform air testing in accordance with the procedures described in ASTM F 1417. Ensure that the equipment is specifically designed and manufactured for testing pipelines with low-pressure air and is provided with an air regulator valve or air safety valve set to prevent the air pressure in the pipeline from exceeding 8 psig. If the results of the air test are unsatisfactory, perform the exfiltration test as outlined above.

The following low-pressure air testing procedures may be used. Ensure that the sewer line has an orifice through which to pass air into the pipe. Connect an air supply to the orifice at one end of the line. The air supply line will contain an on/off gas valve and a pressure gauge with a range of 0 to 5 psi. Ensure that the gauge has minimum divisions of 0.10 psi and has an accuracy of plus/minus 0.04 psi. Properly block the seals at each manhole to prevent displacement while the line is under pressure. Pressurize the pipe line under test to 4 psig. Allow the line to stabilize between 4 psig and 3.5 psig for no less than 5 minutes. If necessary, add air to the line to maintain the pressure above 3.5 psig. After the stabilization period, close the gas valve. When the line pressure drops to 3.5 psig, begin timing with a stop watch. Allow the stop watch to run until the line pressure drops to 2.5 psig. Then stop the watch and compare the time lapse to the allowable time lapse in these Specifications. If the time lapse is greater than that specified, the section undergoing the test shall have passed the low-pressure air test and the test will be discontinued at that time. If the time is less than that specified, the line has not passed the test (see Table 1 for test times).

TABLE 1 AIR TEST TABLE

Length (feet)	4	6	8	10	12	15	18	21	24
25	0:04	0:10	0:18	0:28	0:40	1:02	1:29	2:01	2:38
50	0:09	0:20	0:35	0:55	1:19	2:04	2:58	4:03	5:17
75	0:13	0:30	0:53	1:23	1:59	3:06	4:27	6:04	7:55
100	0:18	0:40	1:10	1:50	2:38	4:08	5:56	8:05	10:34
125	0:22	0:50	1:28	2:18	3:18	5:09	7:26	9:55	11:20
150	0:26	0:59	1:46	2:45	3:58	6:11	8:30	--	--
175	0:31	1:09	2:03	3:13	4:37	5:05	--	--	--
200	0:35	1:19	2:21	3:40	5:17	--	--	--	12:06
225	0:40	1:29	2:38	4:08	5:40	--	--	10:25	13:36
250	0:44	1:39	2:56	4:35	--	--	8:31	11:35	15:07
275	0:48	1:49	3:14	4:43	--	--	9:21	12:44	16:38
300	0:53	1:59	3:31	--	--	--	10:12	13:53	18:09
350	1:02	2:19	3:47	--	--	8:16	11:54	16:12	21:10
400	1:10	2:38	--	--	6:03	9:27	13:36	18:31	24:12
450	1:19	2:50	--	--	6:48	10:38	15:19	20:50	27:13
500	1:28	--	--	5:14	7:34	11:49	17:01	23:09	30:14

3.2.3 Infiltration

After the work is complete, test the sewers or sections for infiltration. Any section in which the infiltration of water is detected will be rejected until corrective work has been performed. No infiltration will be allowed for any one trunk, main, lateral, or segment between manholes.

3.2.4 Exfiltration

The Contracting Officer may require tests for exfiltration. Ensure that exfiltration is in accordance with the requirements of ASTM requirements as modified by the Contracting Officer. Permit an allowance of 10 percent of exfiltration gallonage for each additional 10-foot head over the basic top-of-manhole head.

3.2.5 Television Inspection

Inspect all new sewer mains by internal television inspection, providing accurate distances to all service, with logs and video record of inspection. Provide all equipment and labor for such inspection. Any subcontractor must be approved by the Government before work. Acceptable procedures for televising and video recording are available from the Contracting Officer. Take digital video records of all inspection, including the manholes. Prepare the DVD and, after review by the Contracting Officer, deliver it to the Government. The Contracting Officer or Government's representative shall observe the television inspection.

3.2.6 Alignment and Deflection

Ensure that lines show full circle of light when lamped between manholes for line sections with complete pipe replacement.

Pass a nine-point mandrel through each new flexible pipe section installed after full backfill has been placed. Ensure that the maximum pipe diameter deflection does not exceed 5 percent.

3.2.7 Repair of Piping

At the option of the Contracting Officer, if piping is found to be defective during the warranty test period and if the Contracting Officer does not approve a method of pipe repair by the Contractor, the Contractor shall remove and replace the faulty pipe in an approved manner at no additional cost to the Government.

3.2.8 Tests of Pressure Lines

3.2.8.1 Hydrostatic Test of Aboveground or Exposed Piping

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

Subject the piping system to the test pressure of 150 psi. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.2.8.2 DIP Leakage Test for Buried Piping

Leakage tests shall be conducted concurrently with the pressure test. The duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 150 psi. Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula:

$$L = \frac{SD(P)^{1/2}}{C}$$

in which:

L = allowable leakage (gallons)
S = length of pipe tested (feet)
D = diameter of the pipe (inches)
P = specified test pressure (psig)
C = 133,200

Should any test of laid pipe disclose a leakage greater than that shown, the defective joints shall be located and repaired until the leakage is within the specified tolerance, at no additional cost to the Government.

3.2.8.3 HDPE Leakage Test

The test procedure consists of initial expansion and test phases.

a. During the initial expansion phase, the test section is filled with water. Once the line is filled, make-up water is added at hourly intervals as required to maintain the test pressure for 3 hours.

b. At the end of the initial expansion period, the addition of make-up water will cease. During the test phase the pipe will not have any water added to it for the following 2 hours. The 2 hours will be the actual leakage test. At the end of the 2-hour period, measured make-up water will be added to the pipe to return it to the original test pressure.

c. If the amount of make-up water added is greater than calculated using the numbers listed below, the section being tested will be considered to have a leak. The leak shall be found and fixed at the Contractor's expense and that section of the line retested before continuing with subsequent leakage tests. Testing and repairs shall be repeated at the Contractor's expense until the amount of make-up water is less than the amount calculated using the numbers listed below.

ALLOWABLE FOR EXPANSION UNDER TEST PRESSURE* POLYETHYLENE PIPE

Nominal Pipe Size (inch	**Allowances for Expansion (US Gal/100 Feet of pipe)**		
	1 Hour Test	**2-Hour Test**	**3-Hour Test**
2	0.08	0.12	0.15
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5

Nominal Pipe Size (inch	Allowances for Expansion (US Gal/100 Feet of pipe)		
10	0.75	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
24	4.5	8.9	13.3
30	6.2	12.6	19.1
36	9.0	18.0	27.0
42	12.0	24.0	36.0
48	15.0	27.0	43.0

* These allowances only apply to the test phase and not to the initial expansion phase.

3.3 CLEANING

Thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

3.4 ACCEPTANCE

Sections of the sewer and manholes found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

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SEWAGE LIFT STATIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C207	(2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C550	(2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250
ASME B31.3	(2010) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM B 584	(2009a) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 3753	(2005e1) Glass-Fiber-Reinforced Polyester Manholes and Wetwells

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Corrigendum 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixtures List in accordance with paragraph entitled, "General Requirements," of this section.

Listing of Product Installations

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Design Requirements," of this section.

Erection/Installation Drawings; G
Bypass Pumping and/or Outage Plan; G

SD-03 Product Data

Submit Spare Parts Data also for the following in accordance with paragraph entitled, "General Requirements," of this section.

Submit manufacturer's catalog data and equipment and performance data for the following items:

Package Lift Station; G
Access Covers; G
Sewage Pumps; G
Pump Controls; G
Impellers; G
Nameplate; G
Couplings; G
Stuffing Boxes; G
Valves; G
Quick Disconnect; G
Piping; G
Valve Vault; G
Electric Motors; G
Lift Station Controls; G

Submit paint and manufacturer's recommendations for painting including material storage, mixing, and thinning surface preparation, number and thickness of coats, application drying between coats and final etc. shall be submitted.

Submit the following in accordance with paragraph entitled, "General," of this section:

SD-06 Test Reports

Pump Down Test; G

SD-07 Certificates

Manufacturer Certification

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA; G

1.3 QUALITY ASSURANCE

1.3.1 Drawings

a. Erection/installation drawings shall be submitted showing complete detail, both plan and side view details with proper layout dimensions and elevations.

b. Record drawings for the complete sanitary sewer system shall be submitted showing complete detail with all dimensions, both above and below grade, including invert elevations.

c. Record drawings shall be signed and sealed by a Professional Surveyor. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.4 DESIGN REQUIREMENTS

The lift stations shall have two submersible, centrifugal non-clog or grinder, pumps as specified herein with pump controls capable of operating the pumps either simultaneously or individually, depending on the load conditions.

The Contractor shall submit drawings covering necessary or recommended changes to accommodate the equipment offered. Drawings shall clearly show the wet well, with dimensions and elevation levels with reference to those elevations indicated.

Submit a sanitary sewer bypass pumping and/or outage plan in accordance with the drawings that show the temporary bypass pumping and/or outage plan of the wastewater during renovation/demolition/replacement of the manhole preceding the lift station. The plan shall include pump size and capacity; the methodology of capping influent pipes; a diagram of pumping system, pipe routing, and temporary point of connection to existing lift station.

1.5 NAMEPLATES

Provide the manufacturer's name or trademark on a corrosion-resistant identification plate or cast integrally, on each item of equipment, stamped, or otherwise permanently marked in a conspicuous place. Include on the pump identification plate the pump capacity in gpm, pump head in feet and speed of rotation. Cast on the body of the pump the direction of rotation. Indicate all necessary information to complete identification such as the manufacturer.

1.6 FIELD REPRESENTATIVE

A representative of the lift station pump manufacturer hired by the Contractor shall inspect the pump installation and direct the startup of the station and shall instruct representatives of the Government in startup and operating procedures. The Contractor shall procure the services of the lift station pump manufacturer representative for the following:

1. A minimum of 1 full day on site to inspect, adjust, and test the lift station installation and provide certification as specified.

2. A minimum of 1 full day on site to place the station in operation to demonstrate compliance with the requirements of the Contract Documents.

3. A minimum of 1 full day onsite to train representatives of the Government in the operation, maintenance, and repair of station pumps, control panel, and related appurtenances.

The manufacturer's services specified represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. At no additional cost to the Government, the Contractor shall procure all services required, including additional cost to the Government to the jobsite by the manufacturer's representative to comply with these requirements.

The Contractor shall submit written certification from the lift station pump manufacturer's representative that he has inspected, adjusted, tested, etc., the lift station installation and that all aspects of the installation meet requirements of the pump manufacturer for satisfactory performance and working life of the equipment. The written certification shall state that the system is installed and operating properly and is ready for acceptance by the Government.

1.7 GENERAL REQUIREMENTS

Submit Material, Equipment, and Fixtures List of all major components including manufacturer's catalog numbers, specification and drawing reference number, warranty information, and fabrication site.

Submit Listing of Product Installations similar to the package lift station the Contractor is installing.

Submit Spare Parts Data, including a complete list of parts and supplies with current unit prices and source of supply. List parts and supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished as a part of the contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of one year.

For Lift Station 1B and 9B, the pump supplier shall provide submersible pumps, slide rail assemblies, control panel, float switches, aluminum hatches, and accessories to ensure proper operations and warranty. The complete package pumping station shall have pump bases, rail assemblies, and discharge piping assembled by Hydromax or approved equal and ready for field installation.

Submit an Operation and Maintenance Manual for all components of the lift stations.

PART 2 PRODUCTS

Verify conformance of materials and equipment for package lift station to the referenced publications or as specified. Verify manufacturers are regularly engaged in the manufacture of such products.

Submit manufacturer's data indicating percentage of recycled material content in packaged sewage lift stations to verify affirmative procurement compliance.

2.1 PRECAST WET WELLS AND VALVE VAULTS -- LIFT STATION 4A1, LIFT STATION 4D, LIFT STATION 4N4, LIFT STATION 4S1, LIFT STATION 5C, LIFT STATION 9D

The precast wet wells and valve vaults shall be sized as shown on the drawings and shall conform to the requirements of Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

The precast wet wells shall be lined with the protective liner specified in Section 09 97 24 CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING at the precast factory.

2.2 BASIN AND VALVES VAULTS -- LIFT STATION 1B, LIFT STATION 9B

The basin shall be fiberglass reinforced polyester (FRP) resin with a 3-inch ballast support flange. Each basin shall be furnished with the number of flexible inlet flanges (shipped loose to facilitate field location) to accept the pipe size(s) shown on the Drawings. Inlet and conduit locations can vary to accommodate ease of installation. Basin dimensions shall be as shown on the drawings or as specified herein. The basin FRP wall laminate thickness shall vary with the wetwell depth to provide the aggregate strength to meet the tensile and flexural physical property requirements. The basin FRP wall laminate must be designed to withstand wall collapse or buckling based on a hydrostatic pressure of pounds per square foot, a saturated soil weight of 120 pounds per cubic foot, a soil modulus of 700 pounds per square foot. Basin must comply with the pipe stiffness values as specified in ASTM D 3753. The basin laminate must be constructed to withstand or exceed 150 percent of the assumed loading on any depth. The finished FRP laminate will have a Barcol hardness of at least 90 percent of the resin manufactures specified hardness for the fully cured resin. The Barcol hardness shall be the same for both interior and exterior surfaces. Manufacturer must submit documentation including calculation and production certification that basin (s) on the project comply with the requirements above.

The precast valve vaults shall be sized as shown on the drawings and shall conform to the requirements of Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

2.3 ACCESS COVERS

The access covers for wet wells shall be aluminum plate designed for 300 pounds per square foot live load. The covers shall be securely bolted to each concrete structure with stainless steel hinges and hardware. Covers shall have a diamond pattern non-skid surface and stainless steel recessed handles. Covers shall meet the requirements of Section 05 50 13 MISCELLANEOUS FABRICATIONS.

2.4 HATCH COVER -- LIFT STATION 1B, LIFT STATION 9B

The hatch cover shall be 2/3 hinged to allow maximum access to the wet well. The hatch cover shall be aluminum with stainless steel fasteners, rated for 150 psf or greater. The hatch cover shall include a single or dual door of dimensions specified by the pump manufacturer for proper pump clearance. The cover shall be manufactured by US Fabrication or approved equal.

2.5 SEWAGE PUMPS

2.5.1 Centrifugal Pumps

Provide submersible sewage centrifugal pumps as manufactured by Hydromatic Pumps, or approved equal. The pump volute, motor, and seal housing shall be high-quality gray cast iron in accordance with ASTM A 48/A 48M, Class 30. All fasteners exposed to the pumped liquids shall be 316 stainless steel.

2.5.1.1 Pump and Motor Characteristics

2.5.1.1.1 Lift Station 1G

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	78 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.2 Lift Station 1H

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	37 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.3 Lift Station 1I

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	13 feet

Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.4 Lift Station 1N

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	40 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.5 Lift Station 1P

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	107 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.6 Lift Station 1T

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	75 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.7 Lift Station 4A1

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2

Shutoff Head:	33 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.8 Lift Station 4B2

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Secondary Design Point:	166 gpm at 8 TDH
Shutoff Head:	12 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.9 Lift Station 4C1

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	49 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.10 Lift Station 4D

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	106 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.11 Lift Station 4F

Liquid Pumped:	Raw sewage

Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	51 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.12 Lift Station 4L

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	54 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.13 Lift Station 4N4

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	36 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.14 Lift Station 4N5

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	98 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.15 Lift Station 4N6

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	74 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.16 Lift Station 401

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	17 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.17 Lift Station 5C

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	42 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.18 Lift Station 5D

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	15 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.1.1.19 Lift Station 17C

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	32 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2 Grinder Pumps

Provide submersible sewage grinder pumps as manufactured by Hydromatic Pumps or approved equal. The pump volute, motor, and seal housing shall be high-quality gray cast iron in accordance with ASTM A 48/A 48M, Class 30. All fasteners exposed to the pumped liquids shall be 316 stainless steel.

2.5.2.1 Pump and Motor Characteristics

2.5.2.1.1 Lift Station 4K1

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	91 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.2 Lift Station 4S1

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Secondary Design Point:	20.5 gpm at 65.5 TDH
Shutoff Head:	77.5 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.3 Lift Station 5E

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2

Shutoff Head:	90 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.4 Lift Station 5E2

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	27 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.5 Lift Station 9D

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	57 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.6 Lift Station 17A

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	96 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.2.1.7 Lift Station 17D

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature

Number of Units Required:	2
Shutoff Head:	185 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.3 Grinder Pumps -- Lift Station 1B, Lift Station 9B

Pumps shall be of the submersible type. Each pump shall be mounted on a 2-inch-diameter rail system. The rail system shall be self-engaging resulting in a leakproof coupling. The rail system shall include the base elbow, discharge flange assembly, 1-inch-diameter 304 Stainless Steel guide rails, 316 Stainless Steel upper guide bracket, 316 Stainless Steel lifting bail and cable, and a six-hook 316 Stainless Steel cable holder. The rail system shall be mounted and pre-piped by the pump supplier.

2.5.3.1 Pump and Motor Characteristics

2.5.3.1.1 Motor

The motor shall be mounted in a sealed, submersible type housing. The stator shall be securely held in place with a removable end ring and threaded fasteners for ease of removal without the use of heat or a press. The motor will have two heavy-duty ball bearings, one upper (radial) and one lower (thrust), to support the shaft. The motor shall be equipped with a winding thermostat that automatically shuts the motor off in case of motor overheating.

2.5.3.1.2 Lift Station 1B

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	47 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings
Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.5.3.1.3 Lift Station 9B

Liquid Pumped:	Raw sewage
Pumping Temperature:	Ambient temperature
Number of Units Required:	2
Shutoff Head:	45 feet
Design Conditions:	See drawings
Rated Pump Speed:	See drawings
Motor Power:	See drawings

Discharge Elbow Outlet Diameter:	See drawings
Model:	See drawings
Motors:	Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B

2.6 PUMP CONSTRUCTION

Fabricate castings from cast iron or steel free from injurious defects. Design castings to permit easy replacement of parts. Gasket all joints to prevent leakage under a test pressure equal to 50 percent more than the pump discharge pressure or total dynamic head, whichever is greater. Design and install passageways to permit the smooth flow of sewage and free from sharp turns and projections. Provide pump castings with cleanout plates in the suction line and drain plugs.

2.7 PUMP CONSTRUCTION -- LIFT STATION 1B, LIFT STATION 9B

The pump volute, motor, and seal housing shall be constructed of cast iron, ASTM A 48/A 48M. All external fasteners shall be Series 300 Stainless Steel. The pump shaft shall be constructed of Series 416 Stainless Steel.

2.8 IMPELLERS

For end-suction pumps, impeller shall be non-metallic, semi-open Valox molded to bronze insert. For grinder pumps, impeller shall be red brass ASTM B 584-836. For centrifugal pumps, impeller shall be cast iron. Pump out vanes shall preclude material buildup around the shaft and seal.

Impellers shall be dynamically balanced. The tolerance values shall be according to the International Standard Organization grade 6.3 for rotors in rigid frames. The tolerance is to be split equally between the two balance planes, which are the two impeller shrouds.

2.9 IMPELLERS -- LIFT STATION 1B, LIFT STATION 9B

The impeller shall be of multi-vane, semi-open bronze construction. The impeller shall include pump-out vanes on the back of the impeller and shall be statically and hydraulically balanced.

2.10 CUTTERS -- LIFT STATION 1B, LIFT STATION 9B

A two-stage cutter assembly shall be mounted on the suction side of the pump with direct discharge into the pump impeller. The grinder shall be capable of grinding all materials found in normal, domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, and wood particles into a fine slurry. Both the stationary and rotating cutters shall be constructed of hardened 440C Stainless Steel.

2.11 COUPLINGS

For end-suction pumps, provide heavy-duty flexible type couplings, keyed to the shaft. Provide universal type couplings for vertical pumps.

2.12 SHAFT SLEEVES

For end-suction pumps, protect the shaft from the liquid being pumped, points in contact with the stuffing boxes, and other wearing parts with sleeves designed in bronze or a suitable alloy.

2.13 STUFFING BOXES

For end-suction pumps, grease-seal stuffing boxes with a seal ring, designed to ensure tight packing without excessive wear or friction on the shafts, and prevent the leakage of air or water. Provide split type glands which can be easily removed for repacking.

2.14 BALANCE

Balance rotating parts of the equipment mechanically and hydraulically to operate throughout the required range without excessive end thrust, vibration, and noise. Conform allowable vibration limits with ISO 1940-1, Table 1. Existence of defects that cannot be eliminated by adjustment will be sufficient cause for rejection of the equipment.

2.15 SHAFTS

For centrifugal and grinder pumps, provide high-grade 3300 series stainless steel shafts of a size and strength to perform the work required.

2.16 BEARINGS AND SHAFTS

An upper radial bearing and a lower thrust bearing shall be required. These shall be heavy-duty single-row ball bearings that are permanently lubricated by the dielectric oil that fills the motor housing. Double-row, sealed-grease packed bearings shall not be acceptable. Bearings which require lubrication according to a prescribed schedule shall not be acceptable. The upper radial housing shall have a minimum B-10 life at the specified condition of 40,000 hours and the lower thrust bearing shall have a minimum B-10 life at the specified condition of 40,000 hours.

The shaft shall be machined from a solid 300 series stainless steel forging and shall be designed with a large diameter, having a minimum overhang to reduce shaft deflection and prolong bearing life.

2.17 LUBRICATION

Provide self lubricating, permanently lubed bearings.

2.18 SEALS

The pump shall have two mechanical seals, mounted in tandem, with an oil chamber between the seals. Units that required the use of tungsten-carbide seals or foreign manufactured seals shall not be acceptable.

The pump shall be equipped with a seal leak detection probe and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking the seal chamber oil level and consistency.

Install an electric probe or seal failure sensor in the seal chamber between the two tandem mechanical seals. If the lower seal fails, contaminants which enter the seal chamber shall be detected by the sensor and sent a signal to operate the specified warning device.

Units equipped with opposed mechanical seals shall not be acceptable.

2.19 PIPING CONNECTIONS

Provide pump discharge with flanged connections of the proper size for the pump type and capacity. Conform pipe flanges to ASTM A 536 for ductile iron or gray-iron threaded flanges and piping or AWWA C207. Piping is to conform to the requirements of ASME B31.3.

2.20 VALVES

2.20.1 Check Valve

1. Check valves shall be swing-check type with outside lever and weight and shall permit free flow of sewage forward and provide a positive check against backflow. Check valves shall be designed for a minimum working pressure of 150 psi. The manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow shall be directly cast on the body.

2. Swing check valves shall exceed the minimum requirements of AWWA C508 with a heavy-duty body of cast iron conforming to ASTM A 126 Class B with integral flanges, faced and drilled in accordance with ASME B16.1 Class 125. Bolts, nuts, washers, etc., shall be 316 stainless steel.

3. The valve body shall be the full waterway type, designed to provide a net flow, not less than the nominal inlet pipe size, when swung open no more than 25 degrees. The valve shall have a replaceable stainless steel body seat, a cast iron disc faced with a renewable resilient seat ring of rubber, and shall be held in place by stainless steel screws.

4. The disk arm shall be ductile iron or steel, suspended from and keyed to a stainless steel shaft, which is completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. Where it passes through the body, the shaft shall be sealed by means of a stuffing box and adjustable packing. Simple O-ring shaft seals are not acceptable.

5. The check valve shall be GA Industries, Inc. Figure 220-DS or an approved equal.

6. The valve interior shall be painted with epoxy coating by the valve manufacturer in accordance with AWWA C550. The valve exteriors shall be factory prepared and primed, and field finish painted in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

2.20.2 Check Valves Smaller than 3 Inches

Check valves shall be of solid PVC construction with an external lever and weight. Valves shall incorporate a single disc design suitable for either horizontal or vertical installations. Valves shall be of top entry bonnet design for maintenance purposes. PVC shall conform to ASTM D 1784 Cell Classification 12454-A. Valves shall be rated to 150 psi with EPDM or FKM seals at 70 degrees F. Valves shall be as manufactured by Asahi/America, Inc. or an approved equal.

2.20.3 Plug Valve

Plug valves are specified under Section 33 30 00 SANITARY SEWERS in the paragraph entitled "Plug Valves".

2.20.4 Valves -- Lift Station 1B, Lift Station 9B

Valves shall be sewage swing check with clean-out ports and brass gate valves.

2.21 QUICK DISCONNECT

Quick disconnect shall be rated for a minimum pressure rating of 150 psi and shall be constructed of 316 stainless steel. The quick disconnect outlet shall be male American Standard Taper Pipe Thread. Size shall be as indicated on the drawings. The quick disconnect shall be product number 633-F by OPW or approved equal.

2.22 DUST CAP

The dust cap shall be compatible with the quick disconnect and shall be constructed of 316 stainless steel. The dust cap shall be product number 634-B by OPW or approved equal.

2.23 PIPING

Terminate discharge lines 5-feet outside the lift station in flanged connections. Include the pipe from the wet well manhole in the suction line. External connection joints for pipe using rubber gaskets are to comply with the standards of ASTM C 443.

Piping shall be in accordance with Section 33 30 00 SANITARY SEWERS, except that non-potable piping shall have Protecto 401 interior lining or approved equal.

2.24 ELECTRICAL POWER CORD

Electrical power cord shall be water resistant 600 V, 140 degree F, UL and CSA approved and applied depending on amp draw for size.

The pump shall be triple protected with a compression fitting and two epoxy-potted areas at the power cord entry to the pump. A separation between the junction box area of the pump and motor by a stator lead sealing gland or terminal board shall not be acceptable.

The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to bare wire at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be fitted with an epoxy compound potting that will prevent water contamination from gaining entry if wicking or capillary attraction occurs.

The power cord leads shall then be connected to the motor leads with extra heavy connectors having brass inserts with a screwed wire-to-wire connection.

The connection box wiring shall be separated from the motor housing wiring by stripping each lead down to bare wire, at staggered intervals and separating each strand. This area shall be filled with an epoxy compound potting. Fiberglass terminal boards that are subject to heat fatigue and cracking, and which may lead to possible leaks, shall not be acceptable.

The cord cap assembly where bolted to the connection box assembly shall be sealed with a Buna N Rubber O-ring on a beveled edged to ensure proper sealing.

2.25 ELECTRIC MOTORS

The stator, rotor, and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation, and a dielectric oil-filled motor, NEMA B design.

The pump and motor shall be specifically designed so that they may be operated partially or completely submerged in the liquid being pumped.

Stators shall be securely held in place with a removable end ring and threaded fasteners so they may be easily removed in the field and must be capable of being repaired or rewound by a local motor service station. No special tools shall be required for pump and motor disassembly.

The pump motor shall be equipped with heat sensors. The heat sensors shall be a low-resistance, bi-metal disc that is temperature sensitive. They shall be mounted directly in the stator, sized to open at 250 degrees F, and automatically reset at 90 to 95 degrees F differential. The sensor shall be connected in series with the motor starter coil so that the starter is tripped if a heat sensor opens. The motor starter shall be equipped with overload heaters so all normal overloads are protected by an external heater block.

Each pump motor shall have a sensor to monitor moisture in the stator cavity. Provide a conductivity-sensitive relay for installation in the control panel to alarm excessive moisture content, which may be indicative of an outer mechanical seal FAILURE.

2.25.1 Lift Station Controls

All instrumentation, control, and electrical components provided under this section shall be of an industrial quality equal to the components specified in Division 26, ELECTRICAL, and Section 40 95 00 PROCESS CONTROL SYSTEM, except as noted otherwise.

The instrumentation and controls system, specified herein, shall accept single-phase, 120V, 60-Hz AC electrical power, except were noted herein.

2.25.1.1 Scope

This paragraph (2.20.1 Lift Station Controls) pertains to all the lift stations.

2.25.1.2 Enclosure(s)

Control Panel - 304 SST, NEMA 3R rated, 3-point latch, complete with swing-out, dead-front panel. Provide a solar-shield for each panel as illustrated in the drawings.

2.25.1.3 Operator Interface

Provide the following interface devices:

a. Lift Station Pumps (one complete set for each pump).

   1. HAND/OFF/AUTO selector switch.
   2. 'RUN' status pilot light.
   3. Elapsed time meter.

b. Alarm Annunciation.

1. Alarm horn 'SILENCE' pushbutton.
2. Alarm 'RESET' pushbutton.
3. Pump No. 1 'Seal Leak'.
4. Pump No. 1 'Motor Temp HIGH'.
5. Pump No. 2 'Seal Leak'.
6. Pump No. 2 'Motor Temp HIGH'.
7. Wet Well 'Level High'.

Mount all controls and indicators on the swing-out, dead-front panel. Do not mount any device on the enclosure door.

Mount the alarm beacon and horn on control panel enclosure as indicated on the drawings.

2.25.1.4 External Interfaces

Provide the following signal interface(s) each of which terminated at the terminal strip, clearly designated as external signal interface:

a. Discrete outputs:

1. Control Power ON
2. Pump No. 1 RUN Status
3. Pump No. 2 RUN Status
4. Common Pump FAIL
5. Wet Well Level HIGH

b. Discrete inputs:

The following signals interface with components located in a classified environment (see electrical drawings). Provide suitable safety barrier(s) as needed to comply with NEC.

1. Wet Well Level HIGH HIGH Alarm
2. Wet Well Level START LAG
3. Wet Well Level START LEAD
4. Wet Well Level STOP ALL
5. Wet Well Level LOW LOW Alarm
6. Pump No. 1 Seal Failure
7. Pump No. 1 Motor Temperature HIGH
8. Pump No. 2 Seal Failure
9. Pump No. 2 Motor Temperature HIGH

2.25.1.5 Functional Requirements

a. Provide electro-mechanical (i.e. hard-wired, relay-based logic, using electro-mechanical relays and solid-state logic circuits) controls. The operating functions shall be as specified under 'General Lift Station Sequence of Operation' provided in the drawings, and as provided below.

b. Indicate the ALARM condition, both visually and audibly whenever wet well level exceeds the HIGH HIGH level setpoint. Provide silence function for the audible alarm.

c. Maintain all ALARM conditions until the offending condition is removed and the alarm is manually RESET.

2.25.1.6 Special Requirements

a. Provide and install a control power transformer to convert the 480-VAC, 60-Hz power feed provided to the control panel to 120-VAC, single-phase control voltage. Provide for one power feed to the control panel only.

b. Provide and install a Main Circuit Breaker (MCB) and Generator Circuit Breaker (GCB); the MCB for the power utility 480 VAC, 208 VAC, or 120 VAC as applicable, 60 Hz power feed; and the GCB for the generator 480 VAC, 208 VAC, or 120 VAC as applicable, 60 Hz power feed. Inter-lock the two breakers to avoid having both simultaneously closed. Allow operation of the breaker with the swing-out, dead-front panel closed. Interlock the swing-out panel with the operation MCB/GCB to prohibit opening of the swing-out panel while the MCB/GCB is energized. Provide the generator receptacle as indicated on the drawings.

c. Provide and install motor feed with non-reversing, motor starters for each pump. Allow for operation of the motor feeder circuit breakers with the swing-out, dead-front panel closed. Starters shall be as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES and as shown on the drawings. Equip starters with Solid State Overload (SSOL) relays as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

d. Provide and install non-mercury float switches as noted on the drawings, complete with intrinsically safe relays. Float switches shall be of the suspended type with polypropylene or PVC body. Units shall have an integral electrical cable with two #19 AWG stranded conductors. Switches shall be pilot duty, normally open or normally closed, as required for application.

e. Provide and install elapsed time meters for each motor. The meters shall be non-resettable, having six-digit indication of run time, and resolution of 0.1 hours. Run the meters whenever the pump motor starter is energized.

f. Provide and install a phase-loss/unbalance/reversal and under-voltage protection assembly with adjustable nominal voltage setting. Configure the pump logic to automatically lockout pump operation if all phases drop below 90 percent or of one phase drops below 80-83 percent nominal voltage. The device dropout delay shall be 1/2 second, nominally. The phase failure relay shall be Diversified Electronics.

g. Provide an alarm horn. Mount the alarm horn on the side of the panel.

h. Provide an alarm beacon. Mount the alarm beacon on the top of the panel.

i. Provide and install one (1) convenience receptacle.

2.26 PAINT

Surfaces to be painted include the wet well interior and all piping, conduit, etc., within the wet wells, and aluminum surfaces in contact with concrete.

Provide painting and coatings requirements in accordance with 09 90 00.00 98

PAINTING AND COATING and 09 97 24 CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING.

2.27 GUIDE RAIL ASSEMBLY

If applicable, guide rails shall be mounted to the basin floor on stainless steel riser supports. Guide rails shall be 300 Series stainless steel and size shall be in accordance with the pump manufacturer's recommendation. Each pump shall be equipped with a stainless steel upper and lower guide assembly, stainless steel lifting bail, and stainless steel lifting cable.

PART 3 EXECUTION

3.1 GENERAL

Install lift station as indicated, in accordance with drawings and the manufacturer's instructions.

Preventative Maintenance and Inspection procedure is required for package lift stations sewage pumps. Include in procedures the frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

3.2 PIPING

3.2.1 Flanged and Threaded Joints

3.2.1.1 Flanged Joints

Flanged joints shall be faced true, provided with gaskets, and made perfectly square and tight. Flanged joints shall be used in special cases where connected equipment is available with only flanged joints, or when specifically shown on the drawings.

3.2.1.2 Threaded Joints

Threaded joints shall have graphite or inert filler and oil, graphite compound, or polytetrafluoroethylene (PTFE) tape applied to the male threads only. Unions shall be provided at all screwed valves, strainers and connections to equipment 3/4 inch and smaller. Dielectric unions shall be used at connections of dissimilar metals in 3/4 inch and smaller piping.

3.2.2 Pipe Supports in Valve Vaults

Horizontal and vertical runs of pipe in valve vaults shall be securely supported.

3.3 VALVE VAULTS AND ACCESSORIES

3.3.1 Piping and Equipment in Valve Vaults

Piping and equipment in valve vaults shall be installed to provide easy access without stepping on piping or equipment, and to provide sufficient working room. Piping and equipment in valve vaults shall be installed and supported as shown on the drawings. All plug and check valves shall be installed with the stems horizontal or above.

3.4 TESTS

Commercial testing shall be required and include the following:

The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase, and hertz.

The motor and seal housing chambers shall be meggered to test for moisture content and/or insulation defects.

Pump shall be allowed to run dry to check for proper rotation.

Discharge piping shall be attached, the pump submerged in water and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator will be replaced.

Perform a pump down test to verify that pumps are operating as expected.

For testing of the wet well refer to Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

3.5 OPERATION AND MAINTENANCE

Refer to Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.6 FORMS

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER ____________________________ EQPT SERIAL NO: ____________________

EQPT TAG NO: _____________________ EQPT/SYSTEM: ______________________

PROJECT NO: ______________________ SPEC. SECTION: _____________________

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

_____ Installed in accordance with Manufacturer's recommendations.

_____ Inspected, checked, and adjusted.

_____ Serviced with proper initial lubricants.

_____ Electrical and mechanical connection meet quality and safety standards.

_____ All applicable safety equipment has been properly installed.

_____ System has been performance tested, and meets or exceeds specified performance requirements (when complete system of one manufacturer).

Comments: ____

____

____

____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment, and (iii) authorize the make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _________________________, 20___

Manufacturer: ____

By Manufacturer's Authorized Representative:

____
(Authorized Signature)

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION TESTING AND INSTRUCTION

OWNER

PROJECT

CONTRACT NO.

EQUIPMENT SPECIFICATION SECTION ______________________________

EQUIPMENT DESCRIPTION ______________________________

I ____________________, Authorized representative of
(Print Name)

____
(Print Manufacturer's Name)

hereby CERTIFY that ______________________________
(Print equipment name and model with serial No.)

Installed for the subject project has have been installed in a satisfactory manner, has have been satisfactorily tested, is/are ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the units on Date:

____________________ Time: __________.

CERTIFIED BY: ______________________________ DATE: __________
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGEMENT OF MANUFACTURER'S INSTRUCTION

I/We the undersigned, authorized representatives of the ____________________ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and am are prepared to assume normal operational responsibility for the equipment:

______________________________ DATE: __________

______________________________ DATE: __________

______________________________ DATE: __________

-- End of Section --

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UNDERGROUND ELECTRICAL DISTRIBUTION

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SECTION 33 71 02.00 20

UNDERGROUND ELECTRICAL DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318M	(2008; Errata 2008; Errata 2009) Metric Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO M 198	(2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 32	(2009) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 857	(2007) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; TIA 11-1; Errata 2011) National Electrical Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 1) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast underground structures; G

SD-03 Product Data

Conduit, Ducts and Fittings; G

Precast concrete structures; G

Manhole frames and covers; G

1.4 QUALITY ASSURANCE

1.4.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with ACI SP-66

e. Plans and elevations showing opening and pulling-in iron locations and details

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

Provide in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 33 05 24 DIRECTIONAL DRILLING

2.1.1 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials. Inflatable bladders may be used as an option.

2.2 GROUNDING AND BONDING

2.2.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.2.2 Grounding Conductors

Stranded-bare copper conductors shall conform to ASTM B 8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors shall conform to ASTM B 1 for sizes No. 8 and smaller. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Aluminum is not acceptable.

2.3 CAST-IN-PLACE CONCRETE

Provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.4 UNDERGROUND STRUCTURES

Manhole structure and cover system shall be rated for heavy traffic use, Designation ASTM C 857A-16 (HS20-44) in accordance with ASTM C 857.

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C 857 and ASTM C 478. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable.

2.4.1 Precast Concrete Structures, Risers and Tops

In lieu of cast-in-place, Contractors, at their option, may provide precast concrete underground structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.4.1.1 General

Precast concrete structures shall have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures shall have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction shall be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have a 28-day compressive strength of not less than 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.4.1.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 3 feet below ground elevation

e. Vertical design loads shall include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads shall consider all types and magnitudes of vehicular (automotive, or industrial) traffic to be encountered. The minimum design vertical load shall be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads shall include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, shall be considered, along with a pulling-in iron design load of 6000 pounds.

g. Each structural component shall be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design shall also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.4.1.3 Construction

Structure top, bottom, and wall shall be of a uniform thickness of not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances shall not be permitted. Quantity, size, and location of duct bank entrance windows shall be as directed, and cast completely open by the precaster. Size of windows shall exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

2.4.1.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.4.2 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the word "ELECTRIC" in the top face of power manhole covers.

2.4.3 Brick for Manhole Collar

Brick shall be sewer and manhole brick conforming to ASTM C 32, Grade MS.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.2 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors shall have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C 309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete.

3.2.1 Precast Concrete Construction

Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation shall additionally conform to the manufacturer's instructions.

3.2.2 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices shall be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons shall be a minimum of 6 inches from the edge of the sump, and in the walls the irons shall be located within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron shall not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner shall be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons shall have a clear projection into the structure of approximately 4 inches and shall be designed to withstand a minimum pulling-in load of 6000 pounds. Irons shall be hot-dipped galvanized after fabrication.

3.2.3 Cable Racks, Arms and Insulators

Cable racks, arms and insulators shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart, and each manhole wall shall be provided with a minimum of two racks.Methods of anchoring cable racks shall be as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of bolt into structure. Provide 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel shall be steel of the same length as "vertical rack channel;" channel insert shall be cast flush in structure wall. Provide 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert shall have minimum 800 pound load rating. Provide 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.3 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.3.1 Requirements

Depths to top of the conduit shall be in accordance with NFPA 70 unless indicated otherwise on the drawings. Run conduit in straight lines except where a change of direction is necessary. Numbers and sizes of ducts shall be as indicated. Ducts shall have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 3 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Unless otherwise indicated, provide long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in structures.

3.3.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.3.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.3.4 Multiple Conduits

Separate multiple conduits by a minimum distance of 2 1/2 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

3.3.5 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

3.4 GROUNDING SYSTEMS

Provide grounding system as indicated, in accordance with NFPA 70 and IEEE C2, and as specified herein.

Pad-mounted transformers without protective fences	5 ohms
Ground in manholes	5 ohms
Grounding other metal enclosures of primary voltage electrical and electrically-operated equipment	5 ohms

3.4.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 6 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.

If the specified ground resistance is not met, an additional ground rod shall be provided in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.4.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.4.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.4.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.4.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.4.6 Fence Grounding

Fences shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.4.7 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor and connect to ground rod installed at the manhole. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.4.8 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE Std 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable megohmmeter tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.4.9 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

3.5 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with Section 31 00 00 EARTHWORK.

3.5.1 Reconditioning of Surfaces

3.5.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct or direct burial cable. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

3.5.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.6 CAST-IN-PLACE CONCRETE

3.6.1 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 40 - PROCESS INTEGRATION

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PROCESS CONTROL SYSTEM

-- End of Section Table of Contents --

SECTION 40 95 00

PROCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 587	(1980) Guide/Surge Voltages/Lo-Volt.AC.Power.Circuits
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41.1	(2002; R 2008) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Std 142	(2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)
IEEE Std 802.1d	(2004) Local and Metropolitan Area Networks - Media Access Control (MAC) Bridges
IEEE Std 802.1p	(2004) LAN Layer 2 QoS/CoS Protocol For Traffic Prioritization
IEEE Std 802.1q	(2005) IEEE Standard for local and metropolitan area networks - Virtual bridged local area networks
IEEE Std 802.3	(2009)IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems--Local and Metropolitan Area Networks--Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

	Corrigendum 1: Timing Considerations for PAUSE Operation
IEEE Std 802.3ad	(2000) IEEE Standard for Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications-Aggregation of Multiple Link Segments
IEEE Std 802.3u	(2005) IEEE Local and Metropolitan Area Networks-Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30)
IEEE Std 802.3x	(1997) IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60529	(2009) Degrees of Protection Provided by Enclosures (IP Code)
IEC 61000-4-5	(2005; Corr 2009) Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques; Surge Immunity Test; Ed 2.0

ISA - INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 5.1	(2009) Instrumentation Symbols and Identification
ISA 5.4	(1991)Instrument Loop Diagrams
ISA 50.1	(1982; R 1992) Compatibility of Analog Signals for Electronic Industrial Process Instruments
ISA S50.1	(1982; R 1992) Compatibility of Analog Signals for Electronic Industrial Process Instruments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2010) Terminal Blocks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; TIA 11-1; Errata 2011) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

UNDERWRITERS LABORATORIES (UL)

UL 1059	(2001; Rev thru Dec 2006) Terminal Blocks
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 SYSTEM DESCRIPTION

The process instrumentation and control system project scope is organized in five volumes of work, as illustrated in the drawings. A description of the work items for each volume is as follows:

Volume 1 - Water System

- Water Quality Analyzers, four sites, with remote telemetry units (RTU)

Volume 2 - Lift Stations

- RTU at select lift stations (see drawings)
- Provide, install, and commission a PLC based system to monitor and control two separate wastewater pumping stations. The pump station includes wet well aeration.

Volume 3 - Force Mains

- No work specified in this Section for this volume.

Volume 4 - Water System Additional

- No work specified in this Section for this volume.

Volume 5 - W1 Pump Station Replacement

- Provide, install, and commission a PLC based system to monitor and control a potable water booster pump station and chemical feed system.

The process instrumentation and control system shall facilitate monitoring and control of the process equipment as specified herein and in the drawings (i.e., P&IDs, Sequence of Operation, Control Schematics, and Details. Provide the necessary hardware configured and sized to meet the specified performance requirements.

1.2.1 General Requirements

The following is a brief description of the subcontractor's scope of work, including monitoring and control features required for each volume:

General

Provide one complete Water Quality Analyzer Field Panel as designated in the Volume 1 drawings and one RTU panel "A" as designated in the Volume 2 drawings. Configure with power pig-tails and stands suitable for use as a development or training unit.

Provide full development copies of applications software required to support this project. A list of the anticipated software is provided below:

PLC Programming
Radio Configuration
Operator Interface Configuration

The HMI system is existing. Additional copies of HMI development software is unnecessary.

Volume 1 - Water System

Continuously monitor, on-line, the potable water combined chlorine residual sampled at select locations within the distribution system (see drawings).

Operate (open/close) a solenoid-actuated, flushing valve at these same locations. The operating cycle shall be programmable for frequency and duration which the flushing valve is to be open. Include provisions in the control to initiate the flush cycle prematurely both manually and in the event the chlorine residual falls below an operator entered value.

Provide, install, and configure an RTU at each location to support data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Volume 2 - Lift Stations

Lift Station LS-1AA

Continuously monitor the wet well level and the station's discharge flow rate.

Operate blowers to maintain an aerobic condition in the wet well.

Operate the sewage transfer pumps, varying discharge flow rate step-wise with respect to pre-configured ranges in wet well level using the wet well as a surge basin. The flow rate set points shall be an operator-entered value.

Remove and replace the existing Field Interface Controller (FIC), complete, and re-establish network communication with the KCCS Utility Wide Area Network (WAN) for data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Lift Station LS-4A

Continuously monitor the wet well level and the station's discharge flow rate.

Operate blowers to maintain an aerobic condition in the wet well.

Operate the sewage transfer pumps, varying discharge flow rate step-wise with respect to pre-configured ranges in wet well level using the wet well as a surge basin. The flow rate set points shall be an operator-entered value.

Remove and replace the existing FIC, complete, and re-establish network communication with the KCCS Utility WAN for data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Select Lift Stations

Provide, install, and configure an RTU at each location to support data transmission to/from the Government's SCADA application. Configure the RTU to communicate with KCCS using Modbus TCP and Ethernet protocol. The communication media varies with location, choices being radio telemetry, fiber optic, or copper (Cat 5E). Select lift stations shall communicate using discrete signals via an existing Telephone Termination Cabinet (TTC) with KCCS. Configure the Government's SCADA application for remote monitoring of the facility.

Volume 5 - W1 Pump Station Replacement

W-1 Pump Station - Monitor and control a potable water booster pump station, designed to maintain pressure at station discharge to an operator-entered set point value. Monitor and control a chemical feed system, designed to inject two chemicals, sodium hypochlorite and ammonium sulfate, to produce the system disinfectant, monochloramine. Provide remote monitoring capability via the KCCS.

Implement the controls in a new FIC, connect the FIC to the KCCS Utility WAN for data transmission to/from the Government's SCADA application, and configure the Government's SCADA application for remote monitoring of the facility.

1.2.2 Operation

Provide monitoring and control features as described in the Sequence of Operation and the Control Narratives provided as an Attachment herein.

1.2.3 Points

Inputs and Outputs to be monitored/controlled by the RTUs or FICs are provided in tabular form as an ATTACHMENT to this Section.

1.2.4 Data Transmission Systems (DTS)

Data transmission between the RTUs and the SCADA application shall use the Government's standard, Ethernet-based, communication protocol; Modbus-TCP. Communication media varies with communication site between 900 MHz spread spectrum radio transmission, fiber optic, or copper (Cat 5e).

1.2.5 Process Control System Sub Contractor Responsibilities

The Process Control System Sub Contractor shall complete the detailed design to achieve the performance requirements specified herein. The work includes the following tasks:

Prepare and make the submittals required herein.

Purchase, fabricate, and install equipment and ancillaries.

Provide instructions, details, and recommendations to, and coordinate with the Contractor.

Prepare new screens for and make revisions to the Government's SCADA application data base for the work specified herein. The SCADA application software is Citect.

Configure and commission all smart instruments and devices.

Verify readiness for operation.

Adjust and calibrate instruments

Perform system start up services.

Test the system and coordinate system testing with other trades, the Government, and the Contracting Officer.

Train the Government's staff in system operation and maintenance.

1.3 DEFINITIONS

a. General: Definitions, symbols, and engineering unit abbreviations shall conform to ISA 5.1, as applicable.

b. Abbreviations:

CP: Control Panel
EiRP: Effective Isotropically Radiated Power
FP: Field Panel
HMI: Human/Machine Interface
ISA: Instrumentation Society of America
I/O: Inputs and Outputs
KCCS: Kennedy Complex Communication System
MCC: Motor Control Center
OIU: Operator Interface Unit
ORT: Operational Readiness Test
PAT: Performance Acceptance Test
PICS: Process Instrumentation and Control System

RTU: Remote Telemetry Unit
SCADA: Supervisory Control and Data Acquisition
TTC: Telephone Termination Cabinet

c. Terms:

1. Enclosure: Control panel, console, cabinet, or instrument housing.

2. Instructor Day: 8 hours of actual instruction time.

3. Software: Programs or configuration data for digital devices, stored in read-only memory, programmable read-only memory, read/write memory, disk, tape, or other electronic storage device.

Types of Software:

Standard Software: Package independent of the project on which they are used. Standard software includes system software and Process Monitoring and Control software.

Application Software: Configuration to provide functions unique to this project.

4. Rising/Falling: Terms used to define actions of discrete devices about their set points.

Rising: Contacts close when an increasing process variable rises through set point.

Falling: Contacts close when a decreasing process variable falls through set point.

d. Signal Types:

Analog Signals, Current Type: 4 to 20 mA dc signals conforming to ISA S50.1. Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options.

Transmitter Type:	Number 2, two-wire.
Transmitter Load Resistance Capacity:	Class L.
Fully isolated transmitters and receivers.	

Analog Signals, Voltage Type: 1 to 5 volts DC within panels where a common high precision-dropping resistor is used.

Discrete Signals: Two-state logic signals using 24 V dc or 120 V ac sources as indicated.

Pulse Frequency Signals: Direct current pulses whose repetition rate is linearly proportional to process variable. Pulses generated by contact closures or solid state switches as indicated. Power source less than 30 V dc.

Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

e. Instrument Tag Numbers: A shorthand tag number notation is used in the Loop Specifications. For example: 10PI-2(A/B).

Notation	Explanation
10	Unit process/Loop designation
PI	ISA designator for Pressure Indicator
(2)	Unit designation; alphanumeric designation of same process types in a given loop; -1, -2 in this example
(A/B)	Component designation; Alphanumeric designation of same component type within a process; -A, -B in this example

In this example, 10PI-(2)(A/B) is shorthand for:

10PI-1-A, 10PI-1-B, 10PI-2-A, 10PI-2-B

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panel Fabrication Drawings; G
Installation Drawings; G
Field Wiring Drawings; G

In accordance with the paragraph entitled "DRAWINGS."

SD-03 Product Data

Manufacturer's descriptive and technical literature, performance charts and installation instructions. Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Training Manual; G

Instruction manual within 30 days of Notice to Proceed.

Performance Verification Test (PVT); G

The performance verification test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. Include a list of the equipment to be used during the testing plus manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

SD-05 Design Data

Control Drawings; G

Provide ladder logic or other logic diagrams reflective of the hardwired logic proposed.

SCADA Application 50 Percent Development Submittal; G

Submit color graphic screens representative of the work described herein. The screens shall be produced using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. The submittal shall be reproducible, hard-copy as a minimum.

SCADA Application 90 Percent Development Submittal; G

Submit the completed color graphic screens for the work described herein. The screens shall be produced using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. The submittal shall be reproducible, hard-copy as a minimum. The submittal also shall include one electronic copy of the operational Citect project.

SCADA Application Metadata; G

Submit the metadata for all points monitored/controlled by the Government's existing SCADA application. The Contracting Officer shall provide an example presentation of metadata from previous work. Presentation of the metadata shall comply with this example, be clearly and logically organized, and clearly describe the monitored/controlled data. This data shall be used to facilitate the integration of the Citect projects unique to this work with the Government's overall SCADA application.

SD-06 Test Reports

Radio Path Testing; G

Testing, Adjusting and Commissioning; G
Performance Verification Test (PVT); G

SD-10 Operation and Maintenance Data

Instrumentation and Control System

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions layout, wiring and control diagrams of the system as installed, the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

SD-11 Closeout Submittals

Submit Record Drawings for the completed work.

Submit an annotated copy of the programming code implemented for the FIC. Provide a submittal that is both paper and in electronic format.. Ensure that the electronic format submittal is in a form suitable for access and editing with the FIC hardware programming software.

1.5 SITE ENVIRONMENTAL CONDITIONS

a. Location; Kennedy Space Center

1. Latitude 28.62
2. Longitude 80.72
3. Altitude (above MSL) 16 ft

b. Outside Design Conditions

1. Winter Design Temperature: 35 degrees F

2. Summer Design Temperature: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

c. Inside Design Conditions, Air Conditioned

1. Winter Design Temperature: 62 degrees F
2. Summer Design Conditions: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

d. Inside Design Conditions, Non-Air Conditioned

1. Winter Design Temperature: 45 degrees F
2. Summer Design Conditions: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

1.6 SEQUENCING

Complete the Radio Path Study before to submitting Product Data for the radio towers. If this sequence is not followed, the radio tower submittals will be returned to the Contractor un-reviewed. The radio tower product data submittal shall include the recommended antenna heights presented in the report for each location.

1.7 DRAWINGS

Panel Fabrication Drawings: Detailed drawings illustrating sufficient information for a panel shop to purchase the component parts and fabricate/wire the panel.

Installation Drawings: Detailed drawings illustrating how instruments, panels, and other components are to be installed in the field, complete.

Field Wiring Drawings: Detailed drawings illustrating the termination of analog and discrete signals for instruments and panels in the field. As a minimum, the field wiring drawings shall include 'Analog Loop Diagrams', in compliance with ISA 5.4.

1.8 QUALIFICATIONS

List of project programming/configuring the select PLC logic, completed within the last 3 years.

Certificate of Completion:

Select PLC programming training, sponsored or certified by the PLC manufacturer.

List of projects programming/configuring Citect SCADA, completed within the last 3 years.

Certificates of Completion:

Citect HMI/SCADA configuration training
Cicode Programming

Programming Supervisor contact information (name, address, mobile phone).

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

First Named Manufacturer: PICS design is based on first named manufacturers of equipment and materials.

1. If an item is proposed from other than first named manufacturer, obtain approved from Contracting Officer for such changes in accordance with paragraph entitled "Submittals".

2. If proposed item requires change in system design, (i.e., different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories), the PICS contractor shall be responsible for any additional cost. The PICS contractor shall first obtain approval from the Contracting officer before furnishing equipment and work.

Use product of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

Implement all same or similar functions in same or similar manner. For example, control logic, sequence control, and display layouts.

2.2 GENERAL REQUIREMENTS

The diagrams, as shown in the drawings, are diagrammatic and supplement PICS performance requirements.

PICS functions are as shown on the drawings and as described herein. Furnish equipment items as required. Furnish all materials, equipment, and software necessary to affect required system and loop performance.

Equipment located outdoors, not provided with climate controlled enclosure, shall be capable of operating in the ambient temperature range indicated in paragraph SITE ENVIRONMENTAL CONDITIONS - Outdoor Conditions, unless otherwise specified.

Equipment located inside a structure or building facility without air conditioned environment shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS - Indoor, Non-Air Conditioned, unless otherwise specified.

Equipment located inside a structure or building facility with air conditioned environment shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS - Indoor, Air Conditioned, unless otherwise specified.

Electrical equipment will conform to Division 26 ELECTRICAL. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.3 NAMEPLATES

Provide the manufacturer's name and address and the model and serial number on each major component of equipment in a conspicuous place.

Nameplates shall be laminated plastic and shall identify the device, such as pump "P-1" or valve "VLV-402". Nameplates shall be 1/8 inch thick, white with black center core, 1 by 3 inches in size as a minimum, 1/4 inch high engraved block lettering.

Attach nameplates for devices smaller than 1 by 3 inches using a nonferrous metal chain. All other nameplates shall be physically attached (screwed) to the device.

Coordinate labels with the schedules and the process and instrumentation drawings.

2.4 SCHEDULES

Listed below are schedules included as an ATTACHMENT to this Section. The Contractor shall consider these sections as integral to this Section.

2.4.1 Control Narratives

A description of common functions (motor start/stop, valves open/close, etc.) to be implemented for this work, including the operator interface required at the FIC or KCCS SCADA Application.

Also included are control narratives descriptive of the control performance required for the W1 Pump Station. These narratives are intended to supplement and expand upon the functional descriptions provided in the drawings as Sequence of Operation.

2.4.2 Instrument List

Major components for each loop are listed in the Instrument List referenced in Article ATTACHMENT. Furnish all equipment that is necessary to achieve required loop performance.

2.4.3 RTU and FIC Input/Output List

The Input/Output for each RTU or FIC are listed in the RTU/FIC Input/Output List referenced in Article ATTACHMENT. Furnish all equipment and labor necessary to achieve the required Input/Output.

2.4.4 Component Specifications

Generalized specifications for each type of component are located in Article ATTACHMENT.

2.5 CONTROL PANELS

2.5.1 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring, communications system wiring to KCCS.

All panels shall be UL 508 certified.

2.5.2 Components

2.5.2.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish the enclosure exterior with white baked epoxy, unless otherwise noted. Damaged surfaces shall be repaired and refinished using original type finish.

Enclosures shall be Type 3R, 304 stainless steel unless otherwise noted.

Provide enclosure with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock.

Cutouts shall be cut, punched, or drilled and finished to have smooth rounded edges.

2.5.2.2 Pilot Devices

Indicator lights, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Indicator lights shall be LED type and shall operate at 120 V ac or 24 V dc. Long life bulbs shall be used. Indicator light shall be provided with a legend plate labeled as shown on the drawings. Lens color shall be as indicated on the drawings. Lights shall be push to test (lamp) type.

Selector switches, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Selector switches shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number of positions shall be as indicated on the drawings. Switches shall be non-illuminated. Switches shall be rated for 600 volts, 10 amperes continuous. Selector switches shall be provided with a legend plate labeled as shown on the drawings. Where indicated or required, dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts shall be rated for 120 V ac, 1A as a minimum.

Push buttons, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Push buttons shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number and type of contacts shall be as indicated on the drawings or required by the Sequence of Operation. Push buttons shall be rated for 600 volts, 10 amperes continuous. Push buttons shall be provided with a legend plate labeled as shown on the drawings.

2.5.2.3 Relays

Relays shall comply with IEEE C37.90 and derated for altitude above 1,500 m. Relays shall be double-pole, double-throw (DPDT). Relay coil shall be 120 V ac and shall be provided with matching mounting socket. Power consumption shall not be greater than 3 watts.

2.5.2.4 Terminal Blocks

Terminal blocks shall comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.5.2.5 Alarm Horns

Alarm horns shall be provided where indicated on the drawings. Horns shall be vibrating type and shall comply with UL 508. Horns shall provide 100 dB at 10 feet. Exterior mounted horns shall be weather proof by design or shall be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.5.2.6 Hour Meter

Hour meter shall provide a totalized readout of the number of hours of operation for the equipment monitored. Meter shall provide readout with a minimum of seven (7) digits including 1 decimal place. The display shall be non-resettable. The meter shall be driven by a 120 V ac synchronous motor.

2.5.3 Electrical Requirements

Each panel shall be powered by a dedicated separate 120 V ac circuit, or 120 V ac from a leg of the 3-phase power supply via a control power transform appropriately sized for the anticipated loads, and provided in the panel enclosure. Protect the control power feed with a fuse sized appropriately for the anticipated loads. Provide a suitable disconnect switch internal to the panel for the control power. Electrical work shall be as specified in Division 26 ELECTRICAL and as shown on the drawings.

Certifications or Ratings: All I&C and electrical components, terminals, wires, and enclosures shall be UL recognized or UL listed.

Circuit Breakers: In compliance with NEMA AB 1 and UL 489 35,000 RMS symmetrical rating, minimum at 480 volts, unless otherwise specified. Tripping indication; Operator handle position.

Non-Motor Branch Circuit Breakers: Molded case thermal magnetic.

Motor Branch Circuit Breakers: Molded case with manufacturer's recommended trip setting for maximum motor protection.

50 horsepower or less: Magnetic

Larger than 50 horsepower: Thermal magnetic with adjustable magnetic trips.

Padlock provisions: OPEN position.

Wire within Enclosures:

AC Circuits:

Type: 300-volt, Type MTW stranded copper.
Size: For current to be carried but not less than No. 18-AWG.

Analog Signal Circuits:

Type: 300-volt stranded copper, twisted shielded pairs.
Size: No. 18-AWG minimum.

Other DC Circuits:

Type: 300-volt, Type MTW stranded copper.
Size: No. 18-AWG minimum.

Special Signal Circuits: Use manufacturer's standard cables.

Wire for antenna connection: RG8 type, air-dielectric coaxial cable, solid inner conductor bare copper-clad aluminum, foam polyethylene dielectric, and aluminum tape outer conductor. Jacket shall be black polyethylene. Cable attenuation at 900 MHz shall be 3.9 dB per 100 feet or less. Cable shall be Times Microwave Systems LMR-400 or equal.

Wire Identification: Numbered and tagged at each termination.

Wire Tags: Snap-on or slip-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

Wire entering or leaving enclosures, terminate and identify as follows:

Analog and discrete signal, terminate at numbered terminal blocks.

Special signals terminated using manufacturer's standard connectors.

Identify wiring in accordance with Division 26 ELECTRICAL.

Terminal Blocks for Enclosures:

General:

Provide sufficient terminal blocks necessary to accommodate present, indicate future, and spares, as specified below. Land no more than one (1) wire per terminal block. Wire spare and unused panel mounted elements to their panels' terminal blocks.

Provide twenty (20) percent of all connected terminals but not less than 5 per terminal blocks as spares.

Common Terminal Blocks Configuration:

Connection Type: Screw compression clamp.

Compression clamp: Complies with DIN-VDE 0611. Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection. Clamp shall guide strands of wire into terminal.

Screws: Hardened steel, captive and self-locking.

Current Bar: Copper or treated brass.

Insulation: Thermoplastic rated for minus 55 to 110 degrees C. Insulation shall be shaped at inputs to facilitate wire entry.

Mounting: Stranded DIN rail, suitable to allow Terminal block extraction from an assembly without displacing adjacent blocks.

End Stops: Minimum of one at each end of rail.

Wire Preparation: Stripping only permitted.

Jumpers: Allow jumper installation without loss of space on terminal or rail.

Marking System:

Terminal number shown on both sides of terminal block. Allow use of preprinted and field marked tags. Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

Mark the top of fuse protected terminal blocks with fuse voltage and amperage.

Test Plugs: Soldered connections for 18-AWG wire.

Pin Diameter: 0.079 inch.

Terminal Block, General-Purpose:

Rated Voltage:	600 V ac
Rated Current:	30 amp
Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Gray body
Spacing:	0.25 inch, maximum
Test Sockets:	One screw test socket 0.079-inch diameter
Manufacturer and Product:	Entrelec; Type M4/6.T

Terminal Block, Ground:

Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Green and yellow body
Spacing:	0.25 inch, maximum
Grounding:	Ground terminal blocks electrically

	grounded to the mounting rail
Manufacturer and Product:	Entrelec; Type M4-6.P

Terminal Block, Blade Disconnect Switch:

Rated Voltage:	600 V ac
Rated Current:	10-amp
Wire Size:	22- to 12-AWG
Rated Wire Size:	12-AWG
Color:	Gray body, orange switch
Spacing:	0.25 inch, maximum
Manufacturer and Product:	Entrelec; Type M4/6.SN.T

Terminal Block, Fused, 24 V dc:

Rated Voltage:	600 V dc
Rated Current:	16-amp
Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Gray body
Fuse:	0.25 inch by 1.25 inch
Indication:	LED diode 24 V dc
Spacing:	0.512 inch, maximum
Manufacturer and Product:	Entrelec; Type M10/13T.SFL

Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosure.

Power Distribution within Enclosures:

Feeder Circuits: One or more 120 V ac, 60-Hz feeder circuits. Make provisions for feeder circuit conduit entry. Furnish terminal board for termination of wires.

Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel. Locate to provide clear view of and access to breakers when door is open.

Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker. Branch circuit breakers shall be 15 amps to 250 V ac, maximum/

Breaker Manufacturers and Products: Square D, Type QOU.

Circuit Wiring: Use following rules for actual circuit wiring:

Devices on Single Circuit: 20, maximum.

Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation do not group all units on the same branch circuit.

Branch Circuit Loading: 12 amperes continuous, maximum.

Panel Lighting and Service Outlets: Put on separate 15-amp, 120 V ac branch circuit.

Provide 120-volt AC plug-mold for panel components with line cords.

Signal Distribution:

Within Panels: 40 tó 20 mA DC signals may be distributed as 1 to 5 V dc.

Outside Panels: Isolated 4 to 20 mA DC only.

Signal Wiring: All signal wiring twisted in shielded pairs.

Signal Switching:

Use dry circuit type relays or switches.
No interruption of 4 to 20 mA loops during switching.
4 to 20 mA DC Signals: 0.2 mA, maximum.
1 to 5 V dc Signals: 0.05V, maximum.

Power Supplies:

Provide power for devices requiring external dc power, including two-wire transmitters (instruments) and dc relays. Unit shall convert 120 V ac, 60-Hz power to 24 V dc power, 10 A as a minimum. Provide unit with battery backup to power the connected devices during periods of complete or partial interruption of incoming power. The power supply shall provide sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

Provide output over voltage and over current protective devices to:

Protect instruments from damage due to power supply failure.
Protect power supply from damage due to external failure.

Power supply enclosures shall be NEMA 1 rated in accordance with NEMA 250. Mount such that dissipated heat does not adversely affect other components.

Provide a fuse on the DC supply line to each individual two-wire transmitter in an indicating holder or terminal block. Mount so fuses can be easily seen and replaced.

Provide a fuse on the DC supply line to each individual two-wire transmitter in an indicating holder or terminal block. Mount so fuses can be easily seen and replaced.

The unit shall have sufficient capacity to provide 'trickle charge' to the batteries. Provide the unit with two 7 Ah, 12 V dc lead gel type, wired in series. The assembly shall support continuous no-break power with no measurable transfer time.

The unit shall have isolated contact closures, suitable for external interface, to monitor the following conditions:

AC FAIL
Low Battery
Battery Supervision

The Unit shall be as manufactured by Altronix, or equal.

Electrical Transient Protection:

The electrical transient protection device shall serve to protect elements of PICS against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems. Provide, install, coordinate, and inspect grounding of surge suppressors at:

Connection of AC power to PICS equipment including panels, console assemblies, and field mounted analog transmitters and receivers.

At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.

Connection of data or phone line to PICS equipment.

All field surge suppressors and related enclosures shall be furnished by the PICS Contractor and installed under Division 26, ELECTRICAL. Install in accordance with manufacturer's instructions and installation details provided in the drawings.

Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, ELECTRICAL.

The electrical transient protection device shall be multistage hybrid type responding to a surge within 5 nanoseconds maximum. The device shall recover automatically and shall be suitable for operating within a temperature range of -20 degrees C to 85 degrees C.

Power supply (120 V ac, 60-Hz, single-phase) electrical transient protection devices shall be tested and rated for a minimum of 50 occurrences of IEEE Std 587 Category B test waveform and shall have a first-stage clamping voltage rating of 350 volts or less and a second-stage clamping voltage rating of 210 volts or less. The power supply electrical transient protection device be suitable for continuous operation 30 amps minimum at 130 V ac.

Encapsulate the devices in a flame-retardant epoxy.

Test analog signal lines (1 - 5 V dc or 4 - 20 mA) electrical transient protection devices using a linear waveform, 8 microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half peak value in 20 microseconds. Test and rate the device for 50 occurrences of 2,000-amp peak test waveform.

The device shall exhibit DC clamping 20 to 40 percent above operating voltage for circuit with a tolerance of less than plus/minus 10 percent. The unit shall have a maximum loop resistance of 18 ohms per conductor.

The devices shall be suitable for both field and panel installation. The field-mounted device electronics shall be epoxy-potted (flame-retardant) and encased in a stainless-steel pipe nipple. The panel-mounted device electronics shall be epoxy-potted (flame retardant, suitable for panel or DIN rail mounting).

Field-mounted, two-wire devices shall be EDCO Model No.

SS64-036-2, or equal.

Panel-mounted devices shall be EDCO Model No. PC642 or EDCO Model No. COHOP-036 mounted on compatible mounting blocks or equivalent.

Provide field-mounted four-wire transmitters, e.g. magnetic flowmeter or analyzers (indoor and outdoors) with units that afford hybrid AC power protection and signal line protection in a single NEMA 4X fiberglass enclosure. The combination surge protection units shall be EDCO Model No. SLAC-32036 or approved equal. All signal lines must have surge protections at both panel and field sensor end.

Antenna cable surge suppression shall be dc pass type, complying with IEC 60529 and Bellcore TA-NWT-000487. The unit shall be suitable for use in frequency range from 600 MHz to 2.7 GHz and have an insertion loss of less than 0.1 dB over the frequency range. Unit shall handle maximum surge current of 20kA in compliance with IEC 61000-4-5 for a 8/20 microsecond wave form. Unit shall be Polyphaser DGXE, or equal.

Wiring Within an Enclosure:

Restrain all wiring by plastic ties or ducts or metal raceways. Do not exceed manufacturer's fill recommendations when using plastic ducts or metal wireways. Secure wire passing over a hinged joint at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve. Ducts and wireways mounted inside an enclosure shall be screwed to the panel. Mounting with adhesive or tape is not acceptable.

Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for wire bundles which pass through holes or across edges of sheet metal.

Use locking-fork-tongue or ring-tongue lugs when making connections to screw type terminals. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations. Terminate a maximum of one (1) wire per crimp lug, two (2) per screw terminal.

Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations when making connections to compression clamp type terminals. Terminate a maximum of one (1) wire per terminal.

Splice or tap of wires at device terminals or terminal blocks only.

Terminate 24 V dc and analog signal circuits on separate terminal block from AC circuit terminal blocks.

Separate analog and DC circuits by at least 6 inches from AC power and control wiring except at unavoidable crossover points and at device terminations.

Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

Land all field wiring on terminal blocks and not on individual components, except where noted.

2.5.4 Grounding

Provide a solid copper ground bus for each control panel enclosure. Anchor the ground bus securely to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

2.5.5 Convenience Outlet

Provide one 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.5.6 Panel Interior Light

Provide one 40 watt fluorescent light in any control panel 12 cubic feet in volume or greater. The light shall be operated by a manual on-off switch mounted on the interior door of the enclosure. The light shall be powered by the same circuit as the convenience outlet.

2.5.7 Temperature Control

Size enclosures to adequately dissipate heat generated by equipment mounted on or inside.

PART 3 EXECUTION

3.1 RADIO PATH STUDY

3.1.1 Data Collection

Establish the actual fade margin for each radio link using representative radio, antennas, cable, surge suppressor, and connectors. As a minimum, measure the actual signal strength for a specific link with the antennas located at the heights listed in the Drawings. If required, adjust the antenna heights to achieve a fade margin greater than 20 dB. At no time shall the Contractor operate the radios at EiRP levels in excess of 36 dB, in compliance with FCC Part 15 regulations.

Prepare and submit a report documenting the results of a Radio Path Study. For each radio path, list the measured fade margin, the recommended antenna heights and gain, radio transmission power, and maximum cable/connector losses necessary to achieve or exceed the measured fade margin. Briefly describe in the report the testing protocol and include manufacturer's cut sheets for the radio and antennas documenting conformance with the recommended performance criteria.

3.2 SCADA APPLICATION DEVELOPMENT

3.2.1 Pre-Development Meeting

The Contractor and their SCADA Development Team shall meet with the

Contracting Officer before commencing any programming or configuration efforts with respect to the SCADA Application. At this meeting the Contracting Officer will supply the Contractor with the Government's SCADA graphic and data standard, example graphical screen, Genies, Super Genies, Cicode functions, and metadata for use on this work. This submittal shall be reproducible, hard-copy as a minimum.

3.2.2 50 Percent Development Coordination Meeting

The Contractor and the SCADA Application Development Team shall attend a meeting with the Contracting Officer and team to review the SCADA Application 50 Percent Development Submittal. At that meeting, the Contractor and SCADA Application Development Team shall be prepared to discuss options available to the Government with respect to the configuration, presentation, and control of data graphically on the Government's SCADA application. A consensus will be reached and forwarded onto the Contractor in writing after the meeting. These shall be implemented in the SCADA Application for this project and submitted as the SCADA Application 90 Percent Development Submittal.

3.2.3 90 Percent Development Coordination Meeting

The Contractor and the SCADA Application Development Team shall attend a meeting with the Contracting Officer and their team to review the SCADA Application 90 Percent Development Submittal. The Contractor and SCADA Application Development Team shall perform a live demonstration of the SCADA Application developed for this project. Provide hardware (laptop computer) and software necessary for the demonstration. The Contracting Officer and team shall have the opportunity to operate the application to their satisfaction. A consensus will be reached and forwarded onto the Contractor in writing after the meeting. These shall be implemented in the SCADA Application for this project.

3.2.4 Field Testing

The Contractor and the SCADA Application Development Team shall demonstrate the operation of the SCADA Application in the field as part of the Performance Verification Test (PVT). The Contractor shall provide a computer, complete with Citect SCADA and the specific application developed for the work. The Contractor shall demonstrate to the Government the full function of the SCADA application while communicating with the FIC using the Government's standard communication protocol.

3.2.5 Transfer of SCADA Application

The Contractor shall deliver, in electronic format, a fully documented version of the SCADA Application, complete, to the Contracting Officer for integration in the Government's overall SCADA Application. The Government will perform the final integration of the SCADA Application project prepared for this work.

3.3 DEMOLITION REQUIREMENTS

3.3.1 General

The Contractor shall remove, complete, the existing control panels located at LS-1AA (one panel)and LS-4A (one panel), two floor-mounted panels total. Demolition shall include removal of conduit and conductors in accordance with the requirements of Electrical General Notes, provided in the drawings.

3.3.2 Equipment Salvage

The Contractor shall deliver remove and deliver the PLC and any other electrical components so designated by the Contracting Officer to the Government. The remaining electrical components, wires, and enclosure shall be suitably handled in accordance with Section 02 41 00 DEMOLITION AND DECONSTRUCTION.

3.4 EQUIPMENT INSTALLATION REQUIREMENTS

3.4.1 Installation

Install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Adjust or replace devices not conforming to the required accuracies. Factory sealed devices shall be replaced (rather than adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in Division 26 ELECTRICAL. Wiring in air plenum areas installed without conduit shall be plenum-rated in accordance with NFPA 70.

3.4.1.1 Isolation, Penetrations and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.4.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented and submitted to the Government for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.5 INSTALLATION OF EQUIPMENT

Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.5.1 Control Panels

Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences.

3.5.2 Process Analytical Instrumentation

3.5.2.1 Water Quality Analyzer

Locate analyzer as shown on the drawings and install in accordance with the manufacturer's installation requirements.

3.5.3 Electric Power Devices

3.5.3.1 Potential and Current Transformers

Install potential and current transformers in enclosures unless otherwise shown. Current transformer leads shall be shorted when they are not connected to the measurement circuits.

3.5.3.2 Hour Meters

Meters shall be located in the control panel or as otherwise shown. Power to the meter shall be connected to the motor starter auxiliary contacts for pumps, blowers and other motor driven devices. For devices without motor starters, the meter shall be connected in parallel with the load. Where the meter voltage differs from the metered devices voltage, transformer shall be provided as necessary.

3.5.3.3 Transducers

Transducers shall be wired in accordance with the manufacturer's instructions, and installed in enclosures.

3.5.4 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.

3.5.5 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.5.6 Transformers

Transformers for control voltages 120 V ac or less shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. Provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.6 WIRE, CABLE AND CONNECTING HARDWARE

3.6.1 Metering and Sensor Wiring

3.6.1.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses shall not be used for surge protection.

3.6.1.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection.

3.7 CONTROL DRAWINGS

Provide control drawings, reproducible, with corresponding CADD files for equipment furnished and for interfaces to equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed form, reproducible, with corresponding word processor files and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

3.8 FIELD TESTING AND ADJUSTING EQUIPMENT

Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness the PVT, and written permission shall be obtained from the Government before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

3.8.1 Testing, Adjusting and Commissioning

Upon completion of the installation, test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. Calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop set points, gain constants, constraints, and verify data communications before the system is placed online. Test installed ground rods as specified in IEEE Std 142. Calibrate each instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. Verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power. Deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT procedure.

3.8.2 Performance Verification Test (PVT)

Prepare test procedures for the PVT. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. Demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. Demonstrate that each system operates as required in the sequence of operation.

The PVT shall include field verification of the W1 Pump Station flow meter accuracy, specifically for flows from the specified minimum to a rate where the flow velocity through the meter is 1 fps or greater. Verify the accuracy installed in the field as indicated on the drawings. Verification under other conditions will not acceptable. The means for verifying the meter accuracy shall have a combined uncertainty, as calculated using root mean square, of 0.2 percent of measured flow or better. Demonstrate the flow accuracy at the specified minimum flow and 25, 50, 75, and 100 percent of the flow range from the specified minimum to the flow rate associated with a velocity of 1 fps or greater.

The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, deliver test reports and other documentation as specified to the Government.

3.9 MANUFACTURERS' FIELD SERVICES

Obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.10 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the Contracting Officer. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The Government reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the Government at least 30 days before the training.

3.10.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for one training day. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.10.2 Additional Operator Training

Following the field testing, provide one 4-hour classroom instruction session for operator questions and training consisting of one 2-hour morning session and one 2-hour afternoon session. Instruction shall consist of "hands-on" training under the constant monitoring of the instructor. Classroom training shall include instruction on the specific hardware configuration of the installed control system and specific instructions for operating the installed system.

Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed control system. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations.

Report the skill level of each student at the end of this course.

3.10.3 Maintenance Training

Provide one 4-hour training session by a factory representative or a qualified Contractor trainer on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

3.11 ATTACHMENTS

3.11.1 Control Narratives

General: This section covers functions to be implemented at the project as a whole. These functions pertain to the coverall display and handling of data/events.

FIC Operator Interface

Display Alarm and Status events received as discrete inputs.

Display all monitored parameters received as analog inputs.

Provide LOCAL/REMOTE indication. LOCAL operations means control at the process equipment only. REMOTE operation means remote control via RTU only.

SCADA Application Display:

Display Alarm and Status events received as discrete inputs.
Display all monitored parameters received as analog inputs.
Provide LOCAL/REMOTE indication.

FIC Program Features:

Maintain all Operator entered values (i.e., set points, process, warnings, alarms, and notices).

Maintain Operator control commands (i.e., manual/automatic mode) control.

Upon restoration of power hold all valves at last position and STOP motors. Confirm that the motors have come to a complete stop and all instruments have completed their initialization. Restart the process in a controlled sequence. The sequence will be provided by the Contracting Officer. Restore control to meet current operating conditions and operator set point values. Maintain set point at values entered before power loss.

Maintain all ALARM and FAIL conditions until the alarming event has cleared and the condition is manually RESET.

Common Control Functions:

Below is a description of control function(s) to be used throughout the project regardless of unit process assignment. Where required, these functions will be referenced in the Sequence of Operation by the title(s) provided below. Implement the control functions in the FIC and implement the Operator Interface requirements both at the FIC Operator Interface Unit and the SCADA Application.

START/STOP Motor Control, Non-Reversing:

FIC Operator Interface

START/STOP/AUTO selection
ON/OFF status indication
FAIL alarm event

SCADA Application Display

ON/OFF status indication
FAIL alarm event

FIC Control Functions

Manual Mode: Continuously operate the motor whenever the START/STOP selector is in the START mode. Stop motor operation whenever the START/STOP selector is in the STOP mode. STOP the motor whenever a FAIL alarm event occurs (see below).

AUTO mode: START/STOP the motor in response to internal command signal. Command signal will be identified in Sequence of Operation. STOP the motor whenever a FAIL alarm event occurs (see below).

Establish a FAIL event when any of the following occur:

The START/STOP status is not achieved with an adjustable delay after the START/STOP command is issued.

The starter has a fail or fault condition.

3.11.1.1 Volume 5 - W1 Pump Station Replacement

W1 PUMP STATION BOOSTER PUMP CONTROL UNIT PROCESS 10

Overview:

Provide a Proportional, Integral, Derivative (PID) control for the pump station to maintain an operator adjustable discharge pressure.

Use Adjustable Speed Motor Control common function.

PLC Special Functions:

Operator Interface:

Provide a PID control interface.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide LEAD metering pump selection or AUTOMATIC alternation of lead.

For each pump, provide the following:

Selector switch (START/STOP/REMOTE).
Status Indication (ON/OFF/Remote/Bypass).
Manual Loading Station - Motor Speed.
Analog Meter - Motor Speed.

Control Functions:

Use one PID loop to vary the speed of all booster pumps. The process variable shall be distribution pressure. The PID output variable shall be the common speed signal to each pump VFD. The set point variable shall be adjustable within a range from 70 to

75 psig. Vary the output variable minimum limit based upon an adaptation of the pump affinity laws, as follows:

$$N_{min} = N_{max} * SQRT\{((SP - P_{suct})/P_{TDH}\} + C_{OFF-SET}$$

Where

N_{min} = Calculated minimum pump speed
N_{max} = Maximum pump speed (initially 1775 RPM)
SP = Set Point Value (ft WC)
P_{suct} = Suction Pressure (ft WC)
P_{TDH} = Representative TDH value @ N_{max} (initially 107 ft WC)
$C_{OFF-SET}$ = Constant off set value (initially 10 RPM)

Operate the booster pump in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 500 gpm) and the difference between the discharge pressure set point and the suction header pressure (10PIT-1) is greater than an operator-entered value (initially 24 ft Water Column).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 95 percent) for an operator adjustable period.

STOP the pump with the longest operating time for two or more operating pumps in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 65 percent) for an operator adjustable period.

STOP all pumps whenever either of the following conditions are true:

Demand flow is less than an operator-entered value (initially 350 gpm).

Demand flow is within an operator adjustable range (initially 350 to 1,000 gpm) and discharge pressure is an operator-entered value (initially 2 psig) greater than the pressure set point.

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1st LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

Lead	1st Lag	Standby
1	2	3
2	3	1

Lead	1st Lag	Standby
3	1	2

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Pumps are disabled whenever:

The pump is FAILED.
The associated pump's ASD is FAULTed.
The pump is tagged/locked out.
The pump is in LOCAL control made.
The pump is in BYPASS mode.

Maintain elapsed run times for each individual pump.
Start the timer whenever the pump RUN status is active.
Stop the timer whenever the RUN status is inactive.

Alarms: For each pump, provide the following alarm indication and log each occurrence.

Adjustable Speed Drive FAIL.

The START/STOP status is not achieved with an adjustable delay after the START/STOP command is issued.

High motor winding temperature.

SCADA Application Display:

Operator Interface:

Provide a graphic display schematically representative of the booster pump configuration similar to that illustrated in the drawings (P&IDs).

Provide a PID control interface. The PID Set Point Variable shall be the booster pump station discharge pressure. Do not allow remote, manual adjustment of the PID Output Variable.

Display the LOCAL/REMOTE status for the PID interface.

For each pump, provide the following:

Status Indication (ON/OFF/REMOTE/BYPASS).
Elapsed Run Time Indication.

Control Functions: None.

Alarms: Display the alarms as presented above for PLC Special Functions.

Trends/Reports: Provide a minimum of two preconfigured trend screens. One shall display the suction and discharge pressures (two pens) with respect to time. The other shall display the station flow rate (one pen) with respect to time.

WATER QUALITY MONITORING AND CONTROL UNIT PROCESSES 20 AND 30

Overview:

Monitor the following water quality parameters for the water before chemical addition:

Free Ammonia Residual.
Combined Chlorine Residual (Mono-Chloramine).
Total Chlorine Residual.

Monitor the following water quality parameters for the water after chemical addition:

Combined Chlorine Residual (Mono-Chloramine).
Total Chlorine Residual.

PLC Special Functions:

Operator Interface:

Display the instantaneous water quality parameter values.

Provide for operator-entry of the alarm set points. Alarms are as listed below:

Control Functions: None.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical injection location.

Provide the following alarms whenever the associated water quality parameter exceeds or falls below the operator-entered set point value:

Pre-Chemical Addition:

Combined Chlorine Residual: HIGH and LOW.
Total Chlorine Residual: HIGH and LOW.

Post-Chemical Addition:

Combined Chlorine Residual: HIGH and LOW.
Total Chlorine Residual: HIGH and LOW.

SCADA Application Display:

Operator Interface:

Display the instantaneous water quality parameter values.

Control Functions: None.

Alarm:

Display the alarms as presented above for PLC Special Functions.

Trend/Reports:

Provide a minimum of three preconfigured trend screens. One shall display the pre-chemical addition water quality parameters (three pens) with respect to time. One shall display the post-chemical addition water quality parameters (two pens) with respect to time. And the last shall display all water quality parameters (pre- and post-chemical feed) (5 pens) with respect to time.

SODIUM HYPOCHLORITE FEED SYSTEM UNIT PROCESS 40

Overview:

Provide a flow-paced, chemical feed control loop to scavenge free ammonia residual in the supply water or boost the disinfectant residual. The loop shall work in conjunction with Unit Process 50 Ammonium Sulfate Feed System.

PLC Special Functions:

Operator Interface:

For each pump, provide the following:

Operator Control (ON/OFF/AUTO).
Status Indication (RUN).
Elapsed Run Time Indication.

Display the bulk chemical tank volume, both in feet and in gallons.

Display the chemical flow rate.

Provide a PID control interface for the chemical addition flow rate. The process variable shall be the measured chemical flow rate.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide for Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.
Ammonia Scavenging.

Provide for Operator Entry of the following:

Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

Disinfectant residual set point, and operational dead-band for the system (for use with Total Disinfectant Residual Boost).

Chlorine to Ammonia Ratio (ppm/ppm) set point, and operational dead-band for the system. Limit ratio to a range of 3 to 5.

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions:

Provide PID control of chemical flow rate, varying the stroke rate and number of operating metering pumps as required to achieve operator-entered flow rate value. This mode of operation is designated as 'Chemical Flow Rate, Operator-Entered Rate'.

The remaining modes of operation shall use flow-paced control of the chemical metering pump stroke rate. Pace flow based on the Finished Water Flow rate (20FIT-1).

For 'Flow-Paced, Operator-Entered Dose' mode of operation, provide operator-entry of a chemical dose rate.

For 'Total Disinfectant Residual Boost' mode of operation, provide for Operator-entry of final disinfectant residual. Calculate the dose value as difference between the operator-entered disintectant residual set point and the measured total chlorine residual value of the supplied water (20AIT-1(TCL_2)). Provide a proportional only trim of the residual dose using the finished water total chlorine residual value (30-AIT-1) as the process variable.

For the final mode of operation, Ammonia Scavenging, calculate the dose value as the operator-entered chlorine to ammonia ratio times the free ammonia residual value of the supply water (20-AIT-1).

For all modes of operation, make adjustments to the pump stroke rate whenever the difference between the actual and calculated pump stroke rate values exceed the operator-entered operational dead-band.

Operate the metering pumps in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 200 gpm).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 90 percent) for an operator adjustable period.

STOP the pump with the longest operation time in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 20 percent) for an operator adjustable period.

STOP all pumps whenever the measured demand flow rate (20-FIT-1) is less than an operator-entered value (initially 170 gpm).

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1st LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

Lead	1st Lag	Standby
1	2	3
2	3	1
3	1	2

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Alarms:

Provide an 'Order Sodium Hypochlorite' event whenever either bulk tank volume falls below an operator-entered value.

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

SCADA Application Display:

Operator Interface:

For each pump, provide the following:

Status Indication (ON/OFF/AUTO).
Elapsed Run Time Indication.

Display the bulk chemical tank volume, both in feet and in gallons.

Display the chemical flow rate.

Display LOCAL/REMOTE status for the PID control.

Display the Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.
Ammonia Scavenging.

Display the following:

Operator-entered Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

Operator-entered Disinfectant residual set point, and operational dead-band for the system (for use with Total Disinfectant Residual Boost).

Operator-entered Ratio of Chlorine to Ammonia for chloramine creation.

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions: NA.

Alarm:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

Trend/Reports: None.

AMMONIUM SULFATE FEED SYSTEM UNIT PROCESS 50

Overview:

Provide a flow-paced, chemical feed control loop to boost the disinfectant residual. The loop shall work in conjunction with Unit Process 40 Sodium Hypochlorite Feed System.

PLC Special Functions:

Operator Interface:

For each pump, provide the following:

Operator Control (ON/OFF/AUTO).
Status Indication (RUN).
Elapsed Run Time Indication.

Display the chemical flow rate.

Provide a PID control interface for the chemical addition flow rate. The process variable shall be the measured chemical flow rate.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide for Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.

Provide for Operator Entry of the following:

Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions:

Provide PID control of chemical flow rate, varying the stroke rate and number of operating metering pumps as required to achieve operator-entered flow rate value. This mode of operation is designated as 'Chemical Flow Rate, Operator-Entered Rate'.

The remaining modes of operation shall use flow-paced control of the chemical metering pump stroke rate. Pace flow based on the Finished Water Flower rate (20FIT-1).

For 'Flow-Paced, Operator-Entered Dose' mode of operation, provide Operator-entry of a chemical dose rate.

For 'Total Disinfectant Residual Boost' calculate dose value as difference between the calculated wet point value cascaded from the Sodium Hypochlorite Feed System and the incoming free ammonia residual, as follows:

$$\text{Dose}_{NH3} = \text{Dose}_{TC1} - (\text{Residual}_{NH3} - \text{Ratio})$$

Where

Dose_{NH3} = Calculated dose (ppm)
Residual_{NH3} = Supply Water Total Ammonia Residual (20AIT-1(NH3))
Dose_{TC1} = Calculated dose (ppm) cascaded from UP 40
Ratio = Operator-entered Chlorine to Ammonia Ratio (ppm/ppm) set point

For all modes of operation, make adjustments to the pump stroke rate whenever the difference between the actual and calculated pump stroke rate values exceed the operator-entered operational dead-band.

Operate the metering pumps in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 200 gpm).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 90 percent) for an operator adjustable period.

STOP the pump with the longest operating time in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 20 percent) for an operator adjustable period.

STOP all pumps whenever the measured demand flow rate (20-FIT-1) is less than an operator-entered value (initially 170 gpm).

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1ST LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

Lead	**1st Lag**	**Standby**
1	2	3

Lead	1st Lag	Standby
2	3	1
3	1	2

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

SCADA Application Display

Operator Interface:

For each pump, provide the following:

Status Indication (ON/OFF/AUTO).
Elapsed Run Time Indication.

Display the chemical flow rate.

Display LOCAL/REMOTE status for the PID control.

Display the Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.

Display the following:

Operator-entered Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

LEAD metering pump selection of AUTOMATIC alternation of lead.

Control Functions: NA.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

Trends/Reports: None.

POWER MONITORING UNIT PROCESS 100

Overview:

Monitor the status of the control power in the FIC panel and the status of the Standby Generator. Comply with NFPA 110 Level 1 for the Standby Generator.

PLC Special Functions:

Operator Interface:

For the FIC control power, display when the FIC is on AC or Battery Power.

For the Standby Power Generator, display the alarm conditions listed below.

Control Functions: None.

Alarm Functions:

For the FIC control power, create and display an alarm event whenever the Battery requires service.

For the Standby Power Generator, create and display the following alarm conditions:

Engine Over-crank
Engine Over-speed
Low Temperature, Cooling Water
Low Level, Cooling Water
High Temperature (pre-alarm), Engine
High Temperature, Engine
Low Pressure (pre-alarm) Oil
Low Pressure, Oil
Low Level, Main Fuel Tank
Not IN AUTO, control switch
Low Voltage, Cranking
Common Alarm

These status are transmitted from the Generator control panel (OEM supplied) and the PLC using Serial Communication link.

SCADA Application Display:

Operator Interface:

For the FIC control power, display when the FIC is on AC or Battery Power.

For the Standby Power Generator, display the alarm conditions listed below.

Control Functions: None.

Alarm Functions:

For the FIC control power, create and display an alarm event whenever the Battery requires service.

For the Standby Power Generator, create and display the following alarm conditions:

Engine Over-crank
Engine Over-speed
Low Temperature, Cooling Water
Low Level, Cooling Water
High Temperature (pre-alarm), Engine
High Temperature, Engine
Low Pressure (pre-alarm) Oil
Low Pressure, Oil
Low Level, Main Fuel Tank
Not IN AUTO, control switch
Low Voltage, Cranking
Common Alarm

Trends/Reports: None.

3.11.2 Instrumentation List
Volume 1 - Water Systems

Comp. Code	Tag No.	Component Title	Options	Inst Detail
A22	5-AE/AIT-1	Analyzer and Transmitter, Residual Chlorine	Range: 0 to 5 mg/l	
			Mounting: As specified	
			Process Liquid: Potable Water	
			Type: Combined Chlorine Residual	
A22	6-AE/AIT-1	Analyzer and Transmitter, Residual Chlorine	Range: 0 to 5 mg/l	
			Mounting: As specified	
			Process Liquid: Potable Water	
			Type: Combined Chlorine Residual	
A22	10-AE/AIT-1	Analyzer and Transmitter, Residual Chlorine	Range: 0 to 5 mg/l	
			Mounting: As specified	
			Process Liquid: Potable Water	
			Type: Combined Chlorine Residual	

Comp. Code	Tag No.	Component Title	Options	Inst Detail
A22	17-AE/AIT-1	Analyzer and Transmitter, Residual Chlorine	Range: 0 to 5 mg/l	
			Mounting: As specified	
			Process Liquid: Potable Water	
			Type: Combined Chlorine Residual	

Volume 5 - W1 Pump Station Replacement

Comp. Code	Tag No.	Component Title	Options	Inst Detail
P9	10PIT-1	Pressure Transmitter, Electronic	Range: 0 to 150 psig	
			Indication: Yes	
			Zero: N/A	
			Mounting: Pipe Mount	
			Process Liquid: Potable Water	
P4	10-PI-1XA (X = 1-3)	Pressure Gauge	Range: 0 to 100 psig	
			Mounting: As specified	
			Dial Size: As specified	
			Case Material: As specified	
			Element Material: As specified	
			Damping: Required	
			Process Liquid: Potable Water	

Comp. Code	Tag No.	Component Title	Options	Inst Detail
F23	10-FSL-X (X=1=3)	Flow Element and Switch, Thermal	Operating Pressure: 35 psig max	
			Operating Temperature: Ambient	
			Set Point: 86 gpm	
			Pipe Size: 6-inch	
			Electronics Mounting: Integral	
			Process Liquid: Potable Water	
P4	10-PI-1XB (X = 1=3)	Pressure Gauge	Range: 0 to 100 psig	
			Mounting: As specified	
			Dial Size: As specified	
			Case Material: As specified	
			Element Material: As specified	
			Damping: Required	
			Process Liquid: Potable Water	
F4	20-FE/FIT-1	Flow Element and Transmitter, Electro-magnetic	Line Size: 10-inch	
			Flow Range: 200 to 7500 gpm	
			Process Liquid: Potable Water	
			Unit Digit: 1,000 gallons	
P9	20PIT-1	Pressure Transmitter, Electronic	Range: 0 to 150 psig	
			Indication: Yes	
			Zero: N/A	
			Mounting: Pipe Mount	
			Process Liquid: Potable Water	

Comp. Code	Tag No.	Component Title	Options	Inst Detail
A300	20AIT-1(UV)	UV Percent Transmission Analyzer	Process Variable & Range:	
			Free Ammonia: 0 - 5 mg/l	
			Mono-Chloramine: 0 to 5 mg/l	
			Total Chlorine: 0 to 5 mg/l	
			Option: Dual Stream	
			Mounting: As specified	
			Process Liquid: Potable Water	
A300	30AIT-1(UV)	UV Percent Transmission Analyzer	Process Variable & Range:	
			Free Ammonia: 0 = 5 mg/l	
			Mono-Chloramine: 0 to 5 mg/l	
			Total Chlorine: 0 to 5 mg/l	
			Option: Dual Stream	
			Mounting: As specified	
			Process Liquid: Potable Water	
L5	40-LE/LIT-X (X=1,2)	Level Element and Transmitter, Ultrasonic	Range: 0 to 4 feet	
			Zero: Field Adjust	
			Connection: Flanged	
			Element Material: PVDF	
			Process Liquid: Sodium Hypochlorite	

Comp. Code	Tag No.	Component Title	Options	Inst Detail
L109	40-LSH-1	Level Switch, Rises on Stem	Set Point: Field Set	
			Mounting: Wall Bracket	
			Process Liquid: Dilute Sodium Hypochlorite	
			Options:	
L109	50-LSH-1	Level Switch, Rises on Stem	Set Point: Field Set	
			Mounting: Wall Bracket	
			Process Liquid: Dilute Ammonium Sulfate	
			Options:	

3.11.3 RTU and FIC Input/Output List

Volume 1 Water Systems Inputs/Outputs

Tag Number	Type	I/O	Description	PLC Register
Water Quality Monitoring Stations (Z-CP-1 where Z= 5, 6, 10, & 17)				
Z-AIT-1 (TCL)	Analog	Input	Total Combined Chlorine Residual	
Z-ASL-1 (TCL)	Discrete	Input	Low Combined Chlorine Residual	
Z-HS-1 (INITIATE)	Discrete	Input	START Flush Cycle	
Z-HS-1 (OPEN)	Discrete	Output	OPEN Command, Flush Valve	
Z-QS-1 (FAIL)	Discrete	Input	AC FAIL	
Z-QS-1 (BAT LO)	Discrete	Input	Battery Low	
Z-QS-1 (BAT SUP)	Discrete	Input	Battery Supervision	

Volume 2 Lift Stations Inputs/Outputs

Tag Number	Type	I/O	Description	PLC Register
Lift Station LS-1AA I/O				
100-QS-1 (FAIL)	Discrete	Input	AC FAIL	
100-QS-1(BAT LO)	Discrete	Input	Battery Low	
100-QS-1 (BAT SUP)	Discrete	Input	Battery Supervision	
110-HS-1 (RUN)	Discrete	Output	RUN Command, Blower No. 1	
110-HS-1 (REMOTE)	Discrete	Input	REMOTE Status, Blower No. 1	
110-QS-1 (RUN)	Discrete	Input	RUN Status, Blower No. 1	
110-HS-2 (RUN)	Discrete	Input	RUN Command, Blower No. 2	
110-HS-2 (REMOTE)	Discrete	Output	REMOTE Status, Blower No. 2	
110-HS-2 (RUN)	Discrete	Output	RUN Status (Local), Blower No. 1	

Tag Number	Type	I/O	Description	PLC Register
110-QS-2 (RUN)	Discrete	Input	RUN Status, Blower No. 2	
120-LIT-1	Analog	Input	LEVEL, Wet Well	
120LSH-1	Discrete	Input	HIGH Level, Wet Well	
120LSM-1	Discrete	Input	MEDIUM Level, Wet Well	
120LSL-1	Discrete	Input	LOW Level, Wet Well	
130-QA-1 (FAULT)	Discrete	Input	VFD FAULT, Transfer Pump No. 1	
130-HS-1 (RUN)	Discrete	Output	RUN Command, Transfer Pump No. 1	
130-QS-1 (RUN)	Discrete	Input	RUN Status, Transfer Pump No. 1	
130-QS-1 (REMOTE)	Discrete	Input	REMOTE Status, Transfer Pump No. 1	
130-SI-1	Analog	Input	Speed Status, Transfer Pump No. 1	
130-SIC-1	Analog	Output	Speed Command, Transfer Pump No. 1	
130-QA-2 (FAULT)	Discrete	Input	VFD FAULT, Transfer Pump No. 2	
130-HS-2 (RUN)	Discrete	Output	RUN Command, Transfer Pump No. 2	
130-QS-2 (RUN)	Discrete	Input	RUN Status, Transfer Pump No. 2	
130-QS-2 (REMOTE)	Discrete	Input	REMOTE Status, Transfer Pump No. 2	
130-SI-2	Analog	Input	Speed Status, Transfer Pump No. 2	
130-SIC-2	Analog	Output	Speed Command, Transfer Pump No. 2	
130-FIT-1	Analog	Input	Flow Rate, Transfer Pump Station	
Lift Station LS-4A I/O				
400-QS-1 (FAIL)	Discrete	Input	AC FAIL	
400-QS-1 (BAT LO)	Discrete	Input	BATTERY LOW	
400-QS-1 (BAT SUP)	Discrete	Input	Battery Supervision	

Tag Number	Type	I/O	Description	PLC Register
410-HS-1 (RUN)	Discrete	Output	RUN Command, Blower No. 1	
410-HS-1 (REMOTE)	Discrete	Input	REMOTE Status, Blower No. 1	
410-QS-1 (RUN)	Discrete	Input	RUN Status, Blower No. 1	
410-HS-2 (RUN)	Discrete	Output	RUN Command, Blower No. 2	
410-QS-2 (RUN)	Discrete	Input	RUN Status, Blower No. 2	
410-HS-2 (REMOTE)	Discrete	Input	REMOTE Status, Blower No. 2	
410-QS-1 (RUN)	Discrete	Input	RUN Status, Blower No. 2	
410-HS-2 (RUN)	Discrete	Output	RUN Command, Blower No. 2	
430-QA-1 (FAULT)	Discrete	Input	VFD FAULT, Transfer Pump No. 1	
430-HS-1 (RUN)	Discrete	Output	RUN Command, Transfer Pump No. 1	
430-QS-1 (RUN)	Discrete	Input	RUN Status, Transfer Pump No. 1	
430-QS-1 (REMOTE)	Discrete	Input	REMOTE Status, Transfer Pump No. 1	
430-SI-1	Analog	Input	Speed Status, Transfer Pump No. 1	
430-SIC-1	Analog	Output	Speed Command, Transfer Pump No. 1	
430-QA-2 (FAULT)	Discrete	Input	VFD FAULT, Transfer Pump No. 2	
430-HS-2 (RUN)	Discrete	Output	RUN Command, Transfer Pump No. 2	
430-QS-2 (RUN)	Discrete	Input	RUN Status, Transfer Pump No. 2	
430-QS-2 (REMOTE)	Discrete	Input	REMOTE Status, Transfer Pump No. 2	
430-SI-2	Analog	Input	Speed Status, Transfer Pump No. 2	
430-SIC-2	Analog	Output	Speed Command, Transfer Pump No. 2	
420LIT-1	Analog	Input	LEVEL, Wet Well	
420 LSH-1	Discrete	Input	HIGH Level, Wet Well	

Tag Number	Type	I/O	Description	PLC Register
420LSM-1	Discrete	Input	HIGH Level, Wet Well	
420LSL-1	Discrete	Input	LOW Level, Wet Well	
430FIT-1	Analog	Input	Flow Rate, Transfer Pump Station	
4A1-QS-1	Discrete	Input	Control Power Status	
4A1-QS-1 (RUN)	Discrete	Input	RUN Status, Lift Station Pump No. 1	
4A1-QS-2 (RUN)	Discrete	Input	RUN Status, Lift Station Pump No. 2	
4A1-LSHH-1	Discrete	Input	HIGH HIGH LEVEL, Wet Well	
Lift Station RTU I/O (Z = Station Designation, see drawings)				
Z-QS-1	Discrete	Input	Control Power Status	
Z-QA-1 (LOCAL)	Discrete	Input	LOCAL Status, Lift Station Pump No. 1	Future
Z-QS-1 (RUN)	Discrete	Input	RUN Status, Lift Station Pump No. 1	
Z-HS-1 (RUN)	Discrete	Output	RUN Command, Lift Station Pump No. 1	Future
Z-QA-2 (LOCAL)	Discrete	Input	LOCAL Status, Lift Station Pump No. 2	Future
Z-QS-2 (RUN)	Discrete	Input	RUN Status, Lift Station Pump No. 2	
Z-HS-1 (PUMP 1)	Discrete	Input	LED Pump Selection, Pump No. 1	Future
Z-HS-1 (PUMP 2)	Discrete	Input	LEAD Pump Selection, Pump No. 2	Future
Z-HS-1 (Alt)	Discrete	Input	LEAD Pump Selection, Alternate	Future
Z-LIT-1	Analog	Input	LEVEL, Wet Well	Future
Z-LSHH-1	Discrete	Input	HIGH HIGH LEVEL, Wet Well	
Z-LSH-1	Discrete	Input	HIGH LEVEL, Wet Well	Future
Z-LSM-1	Discrete	Input	MEDIUM LEVEL, Wet Well	Future
Z-LSL-1	Discrete	Input	LOW LEVEL, Wet Well	Future
Z-LSLL-1	Discrete	Input	LOW LOW LEVEL, Wet Well	

Tag Number	Type	I/O	Description	PLC Register
Z-QS-1 (FAIL)	Discrete	Input	AC FAIL	
Z-QS-1 (BAT LO)	Discrete	Input	Battery Low	
Z-QS-1 (BAT SUP)	Discrete	Input	Battery Supervision	

Volume 5 - W1 Pump Station Replacement Input/Outputs

Tag Number	Type	I/O	Description	PLC Register
10-PIT-1	Analog	Input	Pressure, Pump Station Supply	
10-QS-1 (BYP)	Discrete	Input	In Bypass, High Service Pump No. 1	
10-QA-1 (ASD FAULT)	Discrete	Input	ASD FAULT, High Service Pump No. 1	
10-QA-1 (PUMP FAIL)	Discrete	Input	PUMP FAIL, High Service Pump No. 1	
10-QS-1 (RUN)	Discrete	Input	RUN Status, High Service Pump No. 1	
10-QS-1 (REMOTE)	Discrete	Input	IN REMOTE STATUS, High Service Pump No. 1	
10-SI-1	Analog	Input	SPEED Status, High Service Pump No. 1	
10-SIC-1	Analog	Output	SPEED Cmd, High Service Pump No. 1	
10-HS-1 (RUN)	Discrete	Output	RUN Cmd, High Service Pump No. 1	
10-QS-2 (RUN)	Discrete	Input	RUN Status, High Service Pump No. 2	
10-QS-2 (BYP)	Discrete	Input	In Bypass, High Service Pump No. 2	
10-QA-2 (ASD FAULT)	Discrete	Input	ASD FAULT, High Service Pump No. 2	
10-QA-2 (PUMP FAIL)	Discrete	Input	PUMP FAIL, High Service Pump No. 2	
10-QS-2 (REMOTE)	Discrete	Input	IN REMOTE STATUS, High Service Pump No. 2	
10-SI-2	Analog	Input	SPEED Status, High Service Pump No. 2	

Tag Number	Type	I/O	Description	PLC Register
10-SIC-2	Analog	Output	SPEED Cmd, High Service Pump No. 2	
10-HS-2 (RUN)	Discrete	Output	RUN Cmd, High Service Pump No. 2	
10-QS-3 (BYP)	Discrete	Input	In Bypass, High Service Pump No. 3	
10-QA-3 (ASD FAULT)	Discrete	Input	ASD FAULT, High Service Pump No. 3	
10-QA-3 (PUMP FAIL)	Discrete	Input	PUMP FAIL, High Service Pump No. 3	
10-QS-3 (RUN)	Discrete	Input	RUN Status, High Service Pump No. 3	
10-QS-3 (REMOTE)	Discrete	Input	IN REMOTE STATUS, High Service Pump No. 3	
10-SI-3	Analog	Input	SPEED Status, High Service Pump No. 3	
10-SIC-3	Analog	Output	SPEED Cmd, High Service Pump No. 3	
10-HS-3 (RUN)	Discrete	Output	RUN Cmd, High Service Pump No. 3	
10-QS-4 (BYP)	Discrete	Input	In Bypass, High Service Pump No. 4	
10-QA-4 (ASD FAULT)	Discrete	Input	ASD FAULT, High Service Pump No. 4	
10-QA-4 (PUMP FAIL)	Discrete	Input	PUMP FAIL, High Service Pump No. 4	
10-QS-4 (RUN)	Discrete	Input	RUN Status, High Service Pump No. 4	
10-QS-4 (REMOTE)	Discrete	Input	IN REMOTE STATUS, High Service Pump No. 4	
10-SI-4	Analog	Input	SPEED Status, High Service Pump No. 4	
10-SIC-4	Analog	Output	SPEED Cmd, High Service Pump No. 4	
10-HS-4 (RUN)	Discrete	Output	RUN Cmd, High Service Pump No. 4	
20-FIT-1	Analog	Input	Flow Rate, Pump Station Discharge	
20-PIT-1	Analog	Input	Pressure, Pump Station Discharge	

Tag Number	Type	I/O	Description	PLC Register
20-QA-1 (EES)	Discrete	Input	Eyewash/Safety Shower Active, Chemical Injection	
20-AE/AIT-1 (FNH_3)	Analog	Input	Residual, Free Ammonia - Supply Water	
20-AE-AIT-1 (CCL_2)	Analog	Input	Residual, Combined Chlorine (Mono-Chloramine) - Supply Water	
20-AE/AIT-1 (TCL_2)	Analog	Input	Residual, Total Chlorine - Supply Water	
30-AE/AIT-1 (CCL_2)	Analog	Input	Residual, Combined Chlorine (Mono-Chloramine) - Dist. Water	
30-AE/AIT-1 (TCL_2)	Analog	Input	Residual, Total Chlorine - Dist. Water	
40-LIT-1	Analog	Input	Level, Sodium Hypochlorite Tank No. 1	
40-LIT-2	Analog	Input	Level, Sodium Hypochlorite Tank No. 2	
40-QA-1 (EES)	Discrete	Input	Eyewash/Safety Shower Active, Sodium Hypochlorite Area	
40-LAH-1	Discrete	Input	Level HIGH, Sodium Hypochlorite Containment Area	
44-QS-1 (RUN)	Discrete	Input	RUN Status, Sodium Hypochlorite Metering Pump No. 1	
44-HS-1 (RUN)	Discrete	Output	RUN Cmd, Sodium Hypochlorite Metering Pump No. 1	
44-FIC-1	Analog	Output	SPEED Cmd, Sodium Hypochlorite Metering Pump No. 1	
44-QS-2 (RUN)	Discrete	Input	RUN Status, Sodium Hypochlorite Metering Pump No. 2	

Tag Number	Type	I/O	Description	PLC Register
44-HS-2 (RUN)	Discrete	Output	RUN Cmd, Sodium Hypochlorite Metering Pump No. 2	
44-FIC-2	Analog	Output	SPEED Cmd, Sodium Hypochlorite Metering Pump No. 2	
44-QS-3 (RUN)	Discrete	Input	RUN Status, Sodium Hypochlorite Metering Pump No. 3	
44-HS-3 (RUN)	Discrete	Output	RUN Cmd, Sodium Hypochlorite Metering Pump No. 3	
44-FIC-3	Analog	Output	SPEED Cmd, Sodium Hypochlorite Metering Pump No. 3	
44-FIT-1	Analog	Input	Flow Rate Status, Sodium Hypochlorite Feed Skid	
50-QA-1 (EES)	Discrete	Input	Eyewash/Safety Shower Active, Ammonium Sulfate Area	
50-LAH-1	Discrete	Input	Level HIGH, Ammonium Sulfate Containment Area	
54-QS-1 (RUN)	Discrete	Input	RUN Status, Ammonium Sulfate Metering Pump No. 1	
54-HS-1 (RUN)	Discrete	Output	RUN Cmd, Ammonium Sulfate Metering Pump No. 1	
54-FIC-1	Analog	Output	SPEED Cmd, Ammonium Sulfate Metering Pump No. 1	
54-QS-2 (RUN)	Discrete	Input	RUN Status, Ammonium Sulfate Metering Pump No. 2	
54-HS-2 (RUN)	Discrete	Output	RUN Cmd, Ammonium Sulfate Metering Pump No. 2	
54-FIC-2	Analog	Output	SPEED Cmd, Ammonium Sulfate Metering Pump No. 2	

Tag Number	Type	I/O	Description	PLC Register
54-QS-3 (RUN)	Discrete	Input	RUN Status, Ammonium Sulfate Metering Pump No. 3	
54-HS-3 (RUN)	Discrete	Output	RUN Cmd, Ammonium Sulfate Metering Pump No. 3	
54-FIC-3	Analog	Output	SPEED Cmd, Ammonium Sulfate Metering Pump No. 3	
54-FIT-1	Analog	Input	Flow Rate Status, Ammonium Sulfate Feed Skid	
100-QA-1 (AC FAIL)	Discrete	Input	AC Power FAIL	
100-QA-1 (BAT LOW)	Discrete	Input	Battery Power Low	
100-QA-1 (BAT TROUBLE)	Discrete	Input	Battery Supervision Required	
110-QS-1 (UTILITY)	Discrete	Input	ATS on Utility Power	
110-QS-1 (GENERATOR)	Discrete	Input	ATS on Generator Power	

3.11.4 Component Specifications

A. A-22 Residual Chlorine Analyzer/Transmitter:

1. General:

a. Function: Continuously measure, indicate, and transmit combined chlorine residual concentration of sample process stream.
b. Type: Amperometric/membrane.
c. Parts: Analyzer/transmitter unit, mounting hardware, sample tubing and connectors, and expendables (membranes, electrolyte, etc.).

2. Service:

a. Measurement Type: As noted.
b. Sample Flow: 7 to 15 gallons per hour.
c. Sample Supply: Continuous.
d. Sample Temperature Range: 0 to 40 degrees C.

3. Performance:

a. Range: 0 to 20 mg/l.
b. Repeatability: Plus or minus 0.01 mg/l or 0.03 percent of full scale.
c. Response Time: 90 percent change in 60 seconds or less.
d. Accuracy: Plus or minus 0.5 percent of full scale or 0.02 mg/l, whichever is greater.

4. Features:

a. Environmental:
(1) Operating Temperature: minus 20 to plus 60 degrees C.
(2) Operating Humidity: 0 to 95 percent, non-condensing.
b. Display: LCD.
c. Materials of Construction:
(1) Electrode: Gold cathode, silver anode.
(2) Measuring Cell: Acrylic.
(3) Probe Body: Noryl and stainless steel.
d. Instrument Piping Connections:
(1) Sample Line: 1/4-inch OD tube.
(2) Drain Line: 1/2-inch OD tube.

5. Signal Interface:

a. Output: Isolated 4- to 20-mA for load impedance 0 to 800 ohms, minimum, for 24 V dc supply without load adjustment.
b. Contacts: When noted, two SPDT rated 5 A resistive at 230 V ac, minimum.

6. Enclosure:

a. Electronics: NEMA 4x.
b. Instrument Mounting: Wall cabinet mounting, unless otherwise noted.

7. Power Requirements: 24 V dc (loop powered).

8. Manufacturer and Model: Analytical Technology, Incorporated; Model Q45-63 Combined Chlorine Analyzer, or approved equal.

B. A-300 Ultraviolet Absorbence Analyzer and Transmitter:

1. General:

a. Function: Online ultraviolet absorbence analysis.
b. Parts: Analyzer and transmitter.

2. Performance:

a. Wavelength: 256 nm.
b. Spectral Range: 200 to 450 nm.
c. Resolution: 0.5 percent of full scale.
d. Accuracy: 5 percent, plus or minus of full scale.
e. Response Time: User electable updated from 5 to 9999 minutes.
f. Operating Temperature: 32 to 122 degrees F.

3. Analyzer/Transmitter:

a. Dynamic Range: 200 to 400 microns.
b. Sample Flow Rate: 0.132 to 0.40 gpm.
c. Sample Pressure, required: 10 psig minimum.
d. Operator Interface:
(1) Display: 2-line. 20-character backlit LCD.
(2) Data Entry: 4-by-4 keypad.
e. Enclosure:
(1) Suitable for wall mounting.
(2) NEMA 4X IP66, for electronics.
(3) NEMA 3R, for flow cell.
(4) Dimensions: 40 inches high by 20 inches wide by 12 inches deep, nominal.
f. Signal Interface:
(1) 4- to 20-mA DC isolated analog outputs; one per monitored parameter.
(2) Optional RS 232 serial using Modbus protocol.
g. Power: 115 volts AC, 3-wire grounded.

4. Manufacturer and Product:

a. Applied Spectrometry Associates, Inc.; Chemscan® UV 2150S Process Analyzer.
b. Or approved equal.

C. F-4 Flow Element and Transmitter, Electromagnetic:

1. General:

a. Function: Measure, indicate, and transmit the flow of a process liquid in a full pipe.
b. Type: Electromagnetic flowmeter, with operation based on Faraday's Law, using the pulsed dc type coil excitation principle with high impedance electrodes.
c. Parts: Flow element, transmitter, interconnecting cables, mounting hardware, and calibrator.

2. Service:

a. Stream Fluid: As noted.
b. Flow Stream Descriptions: As noted.

3. Performance:

a. Flow Range: As noted.
b. Accuracy: Plus or minus 1 percent of rate for all flows resulting from pipe velocities of 1 to 33 feet per second.
c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

4. Features:

a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
b. No obstructions to flow.
c. Very low pressure loss.

5. Process Connection:

a. Meter Size: As noted.

b. Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.
c. Flange Materials: 316 stainless steel.

6. Signal Interface:

a. 4 to 20 mA dc for load impedance 0 to 800 ohms minimum for 24V dc supply.
b. Digital process variable signal superimposed on 4- to 20-mA signal; using HART® protocol.

7. Power: 170V ac, 60-Hz, unless otherwise noted.

8. Element:

a. Meter Tube Material: Carbon steel.
b. Liner Material: Teflon, unless otherwise noted.
c. Liner Protectors: Covers on each end to protect liner during shipment.
d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
e. Electrode Material: Hastelloy C.
f. Enclosure: NEMA 4X, submersible.
g. Grounding Ring/Electrode Material: 316 stainless steel, unless otherwise noted.

9. Transmitter:

a. Display: Indicating and/or totalizing as noted.
b. Mounting: Pipe stand, wall, panel, or integral as noted.
c. Enclosure: NEMA 4X, should withstand temporary submergence.
d. Zero and Span: Field adjustable.
e. Indicator: Digital 16-character display, with scale range as noted.
f. Totalizer: Digital 16-character display, with totalizer unit digit value as noted.

10. Cables:

a. Types: As recommended by manufacturer.
b. Lengths: As required to accommodate device locations.

11. Calibration System:

a. Features:
(1) Field programmable electronics.
(2) Self-diagnostics with troubleshooting codes.
(3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
(4) Initial flow tube calibration and subsequent calibration checks.
b. Equipment:
(1) Built-in electronics with each unit provided.
(2) Alternatively, one portable calibrator of each type required for the various electromagnetic flowmeters provided on the project.

12. Manufacturers:

a. Siemens Sitran F M.
b. Endress Hauser ProMag.
c. Or equal.

D. F-23 Flow Element and Switch, Thermal:

1. General:

a. Function: Monitor process fluid flow and provide contact closure when flow exceeds set point.
b. Type: Thermal dispersion flow switch using a heated active and a reference RTD temperature sensors to detect rate of flow as a function of the temperature difference between the two sensors.

2. Service:

a. Fluid: Water, unless otherwise noted.
b. Operating Pressure: As noted.
c. Operating Temperature: As noted.

3. Performance:

a. Set Point:
(1) Adjustable throughout full range.
(2) Set as noted.
b. Range: Choose range so that the noted set point is between 30 and 70 percent of the range.
c. Repeatability: Plus or minus 1 percent of full range.
d. Temperature, Operating:
(1) Sensor Element: Minus 100 to plus 350 degrees F.
(2) Electronics: Minus 40 to plus 140 degrees F.
e. Proof Pressure: To 4,000 psig.
f. Response Time: Field adjustable from 10 to 150 seconds.

4. Features:

a. Wetted Surfaces Materials: 316 stainless steel with nickel-base braze, unless otherwise noted.
b. Dry Pipe Protection: When applied to liquid process, furnish protection against the event of the liquid line going dry, unless otherwise noted.
c. Process Temperature Compensation: Furnish.

5. Process Connections:

a. Type: 3/4-inch NPT(M), unless otherwise noted.
b. Pipe Size: As noted.
c. Connection Type: Insertion.
d. Connection Material: 316 stainless steel, unless otherwise noted.
e. Conduit Connection: 1 1/4-inch NPT(F) reduced to 3/4 inch with bushing.

Element: Insertion/Body Length (From Tip of Probe to Process Connection: Determined by the supplier based upon pipe size and sensor mounting requirements, unless otherwise noted. The insertion length shall be noted on an application specific installation detail prepared and submitted for each unit.

7. Electronics:

    a. Location: Integral with element, unless otherwise noted.
    b. Hermetically sealed with SPDT relay.

8. Signal Interface:

    a. Contact: Single-pole, double-throw (SPDT), rated 120V ac, 2 amps.
    b. Connection: Screw terminal block.

9. Enclosure:

    a. Type: NEMA 7BCD with watertight O-ring seal, submersible application.
    b. Material: Epoxy coated, cast aluminum, unless otherwise noted.
    c. Approval: Factory Mutual for hazardous area, unless otherwise noted.

10. Power: 120V ac, 60-Hz, unless otherwise noted.

    a. Cable (Furnished Only When Remote Electronics is Specified).
    b. Type: As required.
    c. Length: As required.

11. Manufacturer:

    a. Fluid Components, Inc.; Model FLT93S.
    b. Delta M Corp., Model FS4100.

E. L-5 Level Element and Transmitter, Ultrasonic:

1. General:

    a. Function: Provide continuous non-contacting level measurement with output proportional to level being sensed.
    b. Type: Ultrasonic.
    c. Parts: Integral level element and transmitter.

2. Service:

    a. Medium: Liquids.
    b. Pressure: 7.25 psig maximum.
    c. Temperature Range: Operating within a range of minus 40 to 176 degrees F.

3. Performance:

    a. Range: As noted.
    b. Zero Reference: As noted.
    c. Sonic Frequency: 54 Hz.
    d. Accuracy: Plus or minus the greater of 0.15 percent of range or 0.24 inches.
    e. Resolution: Less than 1/8 inch.
    f. Repeatability: Less than 1/8 inch.
    g. Blanking Distance: 10 inches.
    h. Update Time: Less than 5 seconds.

4. Features:

a. Display: Integral, multi-segment display providing the following:
   (1) Programmable primary variable:
      (a) Alphanumeric.
      (b) Multi-segment bar graph.
   (2) Primary variable engineering units.
   (3) Sonic echo status.
   (4) Programmable auxiliary variable with engineering units.
Must support signal current at a minimum.
b. Process Connections: As noted.
c. Materials of Construction:
   (1) Probe Head: Polybutylene Terephthalate (PBT).
   (2) Probe Element: As noted.
d. Environmental Rating: NEMA 4/4x.

5. Signal Interface:

a. Output: 4- to 20-mA dc signal for load impedance 0 to 500 ohm minimum of 24V dc supply without load adjustments.
b. Digital process variable signal superimposed on 4- to 20-mA signal; using HART® protocol.

6. Manufacturers:

a. Siemens; SITRAN Probe LU.
b. Or equal.

F. L-109 Level Switch, Miniature, Rises on Stem:

1. General:

a. Function: Actuate contact at preset liquid level.
b. Type: Direct acting; rises on stem.

2. Service: Chemical feed containment area leak detection unless otherwise noted.

3. Performance:

a. Set point as noted.
b. Switch Actuation Point: Approximately one-half distance from end of stem to mounting.
c. Operating Temperature Range: Minus 40 to plus 300 degrees F.

4. Features:

a. Wetted Parts: Polypropylene, solid.
b. Mounting: Stem Mount: 1/8 inch NPT.
c. Signal Interface:
   (1) Switch Type: Magnetic reed switch.
   (2) Switch Contacts.
   (3) Isolated, rated at 20 VA.
   (4) NO or NC (by inverting float on unit stem).
   (5) Lead Wires: No. 22 AWG, 24-inch length.

5. Manufacturer and Product:

a. GEMS; Single Station Liquid Level Switch, Model LS-3.
b. Or equal.

G. P-4 Pressure Gauge:

1. General:

a. Function: Pressure indication.
b. Type:
(1) Direct reading bellows for ranges below 10 psig.
(2) Bourdon tube actuated for ranges 10 psig and above.

2. Performance:

a. Range: As noted. Compound scale when noted.
b. Accuracy: Plus or minus 0.5 percent of span.

3. Features:

a. Mounting: Lower stem, unless otherwise noted.
b. Dial: 4 1/2-inch diameter, unless otherwise noted.
c. Case Material: Phenolic plastic, unless otherwise noted.
d. Element Material: Phosphor-bronze, unless otherwise noted.
e. Dampening: Pulsation dampener when noted, piston type with multiple choice of piston placement to vary the desired amount of dampening.
f. Case Type: Solid front design with solid wall between window and element. Rear of case, gasketed pressure relief.
g. Pointer: Micrometer pointer with self-locking adjustment.
h. Movement: Stainless steel, rotary geared.

4. Process Connection:

a. Line Size: 1/2 inch.
b. Connection Type: Threaded.

5. Manufacturers:

a. Bellows Type: Ashcroft; General Service Series 1180, or equal.
b. Bourdon Tube Type: Ashcroft Duragauge Model 1279/1379, or equal.

H. P-9 Pressure Transmitter, Electronic:

1. General:

a. Function: Measure pressure and transmit signal proportional to pressure or level.
b. Type: Electronic variable capacitance, two-wire transmitter.

2. Performance:

a. Range: As noted.
b. Maximum Adjustable Range: Such that the noted range shall lie between 40 and 80 percent of the maximum adjustable range.
c. Accuracy: Plus or minus 0.075 percent of calibrated span.
d. Temperature: Minus 20 degrees F to plus 200 degrees F, minimum.

3. Features:

a. Type: Gauge pressure, unless otherwise noted.
b. Damping: Fluid or electronic type with adjustment.
c. Indicator: When scale range is noted.
d. Suppressed or Elevated Zero: When noted.
e. Materials: Wetted parts including process flanges and drain/vent valves, 316 stainless steel, unless otherwise noted.
f. Wetted O-Rings: Viton, unless otherwise noted.
g. Housing: Modular with separate compartments for electronics and field connections.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:

a. Line Size: 1/2 inch or 1/4 inch, selectable.
b. Connection Type: FNPT.

5. Signal Interface:

a. 4- to 20-mA dc output for load impedance of 0 to 500 ohms minimum without load adjustment with 24V dc supply.
b. Digital process variable signal superimposed on 4- to 20-mA signal; support HART protocol.

6. Enclosure:

a. Type: NEMA 4X, suitable for temporary submergence, unless otherwise noted.
b. Mounting: Pipe or wall as noted. Provide brackets with Series 300 stainless steel bolts.

7. Manufacturers:

a. Gauge Pressure Units: Rosemount; Alphaline, Model 3051 CG, SMART transmitter.
b. Absolute Pressure Units: Rosemount; Alphaline, Model 3051CA, SMART transmitter.

B. Y-30 Communication Interface Module:

1. General:

a. Function: Serve as a network interface for control components.
b. Performance:
(1) Unit shall support network communication using EtherNet I/P protocol.
(2) Unit shall communicate with the control device using RS-232 or DF-1 Serial Communication protocols. Communication data rates shall be programmable, 2400 to 38.4 Kbaud.
(3) Ethernet communication shall be auto-detecting 10/100 base-T, half- or full-duplex.
c. Features:
(1) Communication Ports:
(a) Ethernet: RJ-45.
(b) Serial: RS232.
(2) Mounting: DIN rail.
d. Power:
(1) Voltage: 24 V dc, maximum.

(2) Current: 100 mA, maximum.
e. Environment:
(1) Temperature: minus 40 to plus 85 degrees C.
(2) Humidity: 55 to 95 percent, non-condensing.
f. Manufacturer and Model: Allen Bradley 1761-NET-ENI, or approved equal.

I. Y-40 Solar Panel and 24 V dc Power Supply with Battery Backup:

1. General:

a. Function: Converts sunlight to regulated 24 V dc power, with 24 V dc battery backup during period of complete or partial interruption of solar power. Unit serves to provide 'trickle-charge' to the battery during period when solar source is available.
b. Major Parts: Solar cells, controller, and sealed batteries.

2. Performance:

a. Capacity: Ability to convert sunlight source to regulated 24 V dc with up to 15 A continuous current. Unit shall have capacity to provide 'trickle charge' for the battery.
b. Output Power: 15 A, 24 V dc, unless otherwise noted.
c. Battery: Two 7 Ah, 12 V dc lead gel backup type, wired in series.
d. Continuous no-break power with no measurable transfer time.
e. Solar panel, measured at STC:
(1) Minimum optimum operating voltage: 30 V dc.
(2) Rated power: 175 W minimum.
(3) Short circuit current rating: 7.15 A.
(4) Performance output:
(a) Through first 10 years: no less than 90 percent.
(b) Years 11 through 25: no less than 80 percent.
f. Power Converter:
(1) Type: Pulse-width modulation, constant voltage.
(2) Operating voltage: 8 V dc, minimum.
(3) Power self-consumption: 22 mA, maximum.
(4) Maximum voltage drops:
(a) Solar to battery: 0.2 V dc.
(b) Battery to load: 0.12 V dc.
(5) High temperature shutdown: 70 degrees C, disconnect solar; 80 degrees C, disconnect load.

3. Features:

a. Solar panel:
(1) Mono-crystalline solar cells.
(2) Anodized aluminum frame.
(3) 4mm thick solar front glass, highly transparent and anti-reflective.
(4) Wind Loading: 125 MPH minimum.
b. Power Controller:
(1) Battery status LED: Color and flash to indicate battery voltage.
(2) LCD display.
(3) Environmental: minus 40 to plus 60 degrees C, 100 percent RH (non-condensing).

4. Manufacturers:

a. Solar cell: HelisUSA 6T Series, or approved equal.
b. Power controller: Morning Start, ProStar PS-15, or approved equal.

J. Y-41 Antennas, Type 1:

1. General:

a. Function: Facilitates transmission and reception of radio signals.
b. Type: Directional Yagi.
c. Parts: Antenna, mounting assembly, support pole, cabling, and accessories.

2. Performance:

a. Radio band: Spread spectrum, 902-928 Mhz.
b. Gain: 11dB.
c. Polarization: Vertical or horizontal.
d. Beam width:
(1) Horizontal: 50 degrees.
(2) Vertical: 40 degrees.
e. VSWR: Less than 1.5.

3. Features:

a. Anodized, solid aluminum elements.
b. Elements brazed to main support.
c. Wind load rating: 120 MPH, minimum.

4. Mounting Assembly:

a. Provide brackets, clamps, and kits as required for a permanent mount.

5. Cabling:

a. Length and cable size: As required.
b. Closed cell foam dielectric core.
c. Impedance: As required.
d. Jacket: Polyethylene.

6. Accessories:

a. Cable surge suppressor: Polyphasor or approval equal.
b. Connectors: As required.
c. Attenuation pads as required to reduce signal strength to within acceptable working limits of radio transceivers.

7. Manufacturer/Model:

a. ZDA Communications US, LLC. 902 to 928 MHz Yagi Antenna, or approved equal.

K. Y-42 Antennas, Type 2:

1. General:

a. Function: Facilitates transmission and reception of radio signals.
b. Type: Directional omni.
c. Parts: Antenna, mounting assembly, support pole, cabling, and accessories.

2. Performance:

   a. Radio band: Spread spectrum, 870-960 MHz.
   b. Gain: 6 dB.
   c. Polarization: Vertical.
   d. Beam width:
      (1) Horizontal: 360 degrees.
      (2) Vertical: 25 degrees.
   e. VSWR: Less than 1.5.

3. Features:

   a. Fiberglass radome construction.
   b. Wind load rating: 125 MPH, minimum.

4. Mounting Assembly:

   a. Provide brackets, clamps, and kits as required for a permanent mount.

5. Cabling:

   a. Length and cable size: As required.
   b. Closed cell foam dielectric core.
   c. Impedance: As required.
   d. Jacket: Polyethylene.

6. Accessories:

   a. Cable surge suppressor: Polyphasor or approved equal.
   b. Connectors: As required.
   c. Attenuation pads as required to reduce signal strength to within acceptable working limits of radio transceivers.

7. Manufacturer/Model:

   a. ZDA Communications US, LLC. 900 MHz Omni Antenna, or approved equal.

L. Y-54 Small Programmable Controller:

1. General:

   a. Function: Multi-loop analog and discrete control.
   b. Type: PLC shall be 'brick' type, i.e. having integral I/O and communication capability, but shall also support I/O expansion.
   c. Parts: Unit shall be all-in-one. No additional parts are required unless noted (i.e. remote I/O or communication interface module).

2. Performance:

a. Memory:
(1) Unit shall have 8 kB of non-volatile, battery backed-up memory, 4kB for user program, 4 kB for data.
(2) Unit shall have capacity of up to 128 kB for data logging.
(3) Unit shall have provisions for addition of removable memory.
b. Instructions:
(1) A minimum of one PID loop.
(2) Support floating-point mathematics.
(3) Real-time clock.
(4) Support on-line, real-time editing.

3. Features:

a. Display: Unit shall have an integral LCD allowing access to monitor/adjust 48 bits and 48 integral values, as a minimum.
b. Trim Potentiometers: Unit shall provide two digital trim potentiometers.
c. Communication: Two channels.
(1) Channel 0: RS-232/RS-485 combination port; RS-232 supporting all serial communication protocols; RS-485 supporting DH-485, DF-1 half-duplex, ASCII, Modbus RTU Master/Slave.
(2) Channel 1: RJ-45, supporting EtherNet I/P messaging (peer-to-peer).

4. Power Supply: Integral to unit using 12 or 24 V dc.

5. Input/Output (I/O):

a. Integral to unit.
b. General requirements:
(1) Unit shall have integral a minimum of two isolated digital input groups, one isolated analog input group, and six isolated relay output groups. All relays shall be individually isolated.
(2) Unit shall support a maximum of 80 discrete I/O using expansion modules.
(3) Unit shall support a minimum of four expansion modules (input/output, discrete, and analog).
c. Specific requirements:
(1) Discrete input: Ten 12 or 24 V dc sink or source, four high speed (40KHz catch).
(2) Output: Six, individual, isolated, relay contacts.
(3) Analog Input: Two, 0 to 10 V dc, non-isolated, 10-bit resolution.

6. Programming Software:

Suitable for programming the PLC processor, communication interface module, and expansion I/O Modules:
a. Ladder diagram and function block diagram.
b. Provides communication configuration support for serial protocols.
c. Product:
(1) RS Logix 500 or approved equal.

7. Environmental Requirements:

a. Operating temperature: Minus 4 to plus 149 degrees F.

b. Relative humidity: 5 to 95 percent, non-condensing.

8. Manufacturer and Product:

Allen-Bradley MicroLogix 1100, or approved equal.

M. Y-55 Programmable Logic Controller (PLC):

1. General:

a. Function: Processor with communication ports.
b. Type: Capable of initiating communication.
c. Parts: processor, power supply, battery, I/O chassis, I/O modules and cabling.

2. Processor Features:

a. Central processing unit (CPU): Processor: 16 bit, minimum.
b. Memory:
   (1) User logic: 16 K words.
   (2) Data: 24 Kbytes.
c. Scan time: Less than 1 msec per 1,000 words.

3. Communication:

a. Ports:
   (1) One (1) RJ-45.
   (2) One (1) RS-232.
b. Protocols:
   (1) Ethernet.
   (2) Data highway (DH-485), DF1, ASCII.

4. Diagnostics:

a. As a minimum, the CPU shall monitor the following system failures:
   (1) Memory failure.
   (2) Input/Output subsystem error.
   (3) Watchdog timer time out.
   (4) Upon failure detection, the CPU shall provide a discrete output.

5. Programming:

a. Programming language: Ladder logic.
b. Minimum basic operations:
   (1) Binary logic operation.
   (2) Timers and counters.
   (3) Shift registers.
   (4) Drum sequencers.
   (5) Enhanced operations.
   (6) Four-function integer math.
   (7) Word shift registers.
   (8) Word compare.
   (9) Word move.
   (10) Two PID controllers, as a minimum.

6. Data Input/Output:

a. Discrete Input:
   (1) Quantity: 16 inputs.
   (2) Type: V dc, sinking.
   (3) Nominal operating voltage: 48 V dc.
   (4) Status indication: LED.
b. Discrete Output:
   (1) Quantity: 8 outputs.
   (2) Type: Relay, rated 8.0 amperes continuous at 120 V ac.
   (3) Nominal operating voltage: 48V dc.
   (4) Status indication: LED.
c. Analog Input, Differential:
   (1) Signal quantity: 8 inputs.
   (2) Type: 4 - 20 mA.
   (3) Isolation:
      (a) Between channels: 200 V dc for 1 minute.
      (b) Between channel and ground: 1780 V ac for 1 minute.
      (c) Resolution: 12 bit, minimum.
   (4) Status indication: LED.
d. Analog Output, Differential:
   (1) Signal quantity: 4 outputs.
   (2) Type: 4 - 20 mA.
   (3) Isolation:
      (a) Between channels: 200 V dc for 1 minute.
      (b) Between channel and ground: 1780 V ac for 1 minute.
   (4) Resolution: 12 bit, minimum.
   (5) Status indication: LED.

7. Environmental Requirements:

Mount each PLC, its power supply, and I/O modules inside the specified control panels or as shown on the drawings.

a. Operating temperature: 0 to 45 degrees C.
b. Humidity Rating: 5 to 95 percent, non-condensing.

8. Power Supply:

PLC equipment shall operate on 120 V ac, plus or minus 10 percent, single-phase, 60-Hz, plus or minus 0.5-Hz power.

9. Manufacturer and Product:

Allen Bradley SLC 5/05 Processor with Series 1746 I/O System, or approved equal.

N. Y-57 Radio, Spread Spectrum:

1. General:

a. Function: Supports wireless communication between devices.
b. Type: Radio transceivers, frequency hopping spread spectrum.

2. Environmental:

a. Operating temperature range: Full performance from minus 22 to plus 140 degrees F.
b. Humidity rating: 95 percent relative humidity at 104 degrees F.
c. Enclosure: Die-cast aluminum.

3. Performance:

   a. Radio band: 902-928 MHz, part 15 spread spectrum.
   b. Frequency hopping range: 8 selectable zones, each containing 128 frequencies.
   c. Operation: Half duplex or simplex.

4. Data Characteristics:

   a. Connectivity: RS-232.
   b. Communication rates: 1200, 2400, 4800, 9600, 19200 bps asynchronous.
   c. RF channel data rate: Selectable between 512 and 256 kbps.
   d. Average latency: less than 10 ms, typ.

5. Transmitter:

   a. Carrier power output: 1 watt maximum.
   b. Duty cycle: Continuous.

6. Receiver Sensitivity:

   a. 256 kbps data transmission: -99 dBm with 10^{-6} bit error rate (BER)
   b. 512 kbps data transmission: -92 dBm with 10^{-6} bit error rate (BER)

7. Power:

   a. 24 V dc nominal.
   b. Reverse polarity protection.

8. Diagnostics:

   a. Received signal strength.
   b. Main supply voltage.
   c. Internal temperature.
   d. Signal to noise ratio.
   e. Radio status.
   f. Radio Alarm and status indication.
      (1) External LEDs.

9. Accessories:

   a. Six-foot pigtail power connector.

10. Manufacturer/Model

   a. California Microwave, Microwave Data Systems, Model iNet 900™, or approved equal.

O. Y-63 Operator Interface Unit (OIU):

1. General:

   a. Function: Operator interface to PLC.
   b. Type: Touch screen.

2. Environmental:

   a. Operating temperature: 0 to 45 degrees C.
   b. Humidity rating: 10 to 90 percent, non-condensing.

3. Performance:

   a. CPU shall be 32 bit RISC operating at 400 MHz, as a minimum.
   b. Enclosure: Rating: NEMA 4.
   c. Display:
      (1) Type: 256 color DSTN.
      (2) Size: 10-inch.
      (3) Back light: CCFT.
   d. Application memory: 512 Kbyte flash, minimum.
   e. Touchscreen:
      (1) Type: 4-wire analog resistive.

4. External Interface:

   a. Communication ports:
      (1) Network: One port; Ethernet (Modbus TCP/IP).
      (2) Serial: Two ports.

5. Electrical Requirements: 120 V ac, single-phase, 60-Hz.

6. Accessories: Configuration software, MS Windows compatible.

7. Manufacturer and Model: Maples Systems; HMI 5100N, or approved equal.

P. Y-76 Managed Network Switch, 8-Port, FX/FX, Single-Mode

1. General:

   a. Managed Ethernet switch, operating on OSI Layer 2.
   b. Serves as copper-to-optical converter, suitable for use with single-mode fiber optic, unless otherwise noted.

2. Power: 120 V ac, 60 Hz, 17 W.

3. Physical Characteristics:
   a. Physical Dimensions: 10 x 5.4 x 1.75 inches.
   b. Connections:
      (1) Eight (8) RJ-45.
      (2) One (1) SC pair.
   c. Status Indication:
      (1) Power ON.
      (2) TP (Duplex/Link/Activity).
      (3) TP (10 Mbps, 100 Mbps, 1000 Mbps).
      (4) LACT (Fiber Link/Active).

4. Switch Performance:

   a. Eight (8) port 10/100 Base T, Half/Full Duplex in compliance with IEEE Std 802.3 and IEEE Std 802.3u.
   b. 8K MAC address table, with auto-learn
   c. VLAN tagging in compliance with IEEE Std 802.1q. Port-based VLANs and overlapping VLANs
   d. IEEE Std 802.1p Class of Service with 2-level priority queuing

b. Fiber:
   (1) Multi-Mode 62.5/125 um.
   (2) Light wave length: 1310 nm.
   (3) Optic link budget: 15 dB/2 km.
c. Electric link budget: 100 m.

5. Transceiver Performance:

   a. Light wave: 1300 nm.
   b. Optic link budget: 11 db/4,000m.

6. Configuration and Troubleshooting:

   a. Interface: Console port, Web-based GUI, Telnet, and SNMP
   b. IEEE Std 802.1d Spanning Tree
   c. IEEE Std 802.3x Flow Control
   d. IEEE Std 802.3ad Broadcast storm filter
   e. Diagnostics: Provide LED status indication for the following:
      (1) Power.
      (2) 100 M operation.
      (3) LK/ACT
      (4) FD/COL

7. Environment:

   a. Enclosure: NEMA 1/IP20.
   b. Temperature: 0 to 45 degrees C.
   c. Humidity: 10 to 95 percent, noncondensing.

8. Manufacturer and Product:

   a. Transition Network, MIL-SM801P(XX).
   b. Or Equal.

Q. Y-85 Light Interface Unit (LIU), 12 Fiber:

1. General:

   a. Function: LIU that interfaces fiber optic cable to electronic equipment.
   b. Type: Uses flexible fiber optic cable assemblies (patch cords).
   c. Parts: Interconnect center, two connector panels, patch cords, including spares.

2. Features:

   a. Interconnect Center:
      (1) 12-fiber modular unit.
      (2) Two installed 6-fiber capacity connector panels.
      (3) Adapters per each connector panel: Six SC compatible single-mode adapters with plastic insert installed.
      (4) Wall-mounted.
      (5) Strain relief for multiple cables.
   b. Fiber Optic Cable Assemblies:
      (1) Quantity: As required for application plus two spare zipcord cables per LIU.
      (2) Length: As required.
      (3) SC Compatible, PC Composite, multimode.

(4) Zipcord cable: 2 fibers per cable.
(5) Fiber type: 62.5 micrometers.
(6) Attenuation (db/km): 3.75/1.5.
(7) Bandwidth (MHz/km): 160/500.

3. Manufacturer and Model:

a. Corning Cable Systems: Wall-Mountable Interconnect Center (WIC), or approved equal.

R. Y-87 Media Converter, Ethernet

1. General:

a. Stand alone media converter used to convert 10/100/1000Base TX UTP to 1000Base FX Ethernet.
b. Fiber optic shall be multi-mode, unless otherwise noted.

2. Power: 12 V dc, 1.25 A unregulated, standard.

3. Physical Characteristics:

a. Physical Dimensions: 3.25 x 4.8 x 1 inches.
b. Connections:
(1) One RJ-45.
(2) One SC pair.
c. Status Indication:
(1) Power ON.
(2) TP (Duplex/Link/Activity).
(3) TP (10 Mbps, 100 Mbps, 1000 Mbps).
(4) LACT (Fiber Link/Active).
d. Enclosure: NEMA 1/IP20.
e. Temperature: 0 to 50 degrees C.
f. Humidity: 5 to 95 percent, noncondensing.

4. Performance:

a. Communication Protocol: Ethernet (IEEE Std 802.3, IEEE Std 802.3ab, IEEE Std 802.3u, IEEE Std 802.3z.
b. Fiber:
(1) Multi-Mode 62.5/125 um.
(2) Light wave length: 1310 nm.
(3) Optic link budget: 15 dB/2 km.
c. Electric link budget: 100 m.

5. Manufacturer and Product:

a. Transition Network.
b. Or Equal.

-- End of Section --

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SECTION 43 32 69

CHEMICAL FEED SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z400.1	(2004) Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2010) Hypochlorites
AWWA B302	(2005) Ammonium Sulfate

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM D 1693	(2008) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 638	(2010) Standard Test Method for Tensile Properties of Plastics
ASTM D 790	(2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM F 468	(2010) Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F 476	(1984; R 2002) Standard Test Methods for Security of Swinging Door Assemblies

HYDRAULIC INSTITUTE (HI)

HI 7.1-7.5	(2002) Controlled Volume Metering Pumps
HI 9.1-9.5	(2000) Pumps - General Guidelines for

Types, Applications, Definitions, Sound Measurements and Documentation

NSF INTERNATIONAL (NSF)

NSF/ANSI 61 (2010a) Drinking Water System Components - Health Effects

1.2 SYSTEM DESCRIPTION

Provide a chemical feed system consisting of a chemical supply storage tank from which the chemical solution is pumped through piping or tubing, as appropriate, to the point of application. Include with each chemical feed system controlled volume pumps, tanks, gauges, back pressure regulators, strainers, pressure relief valves, sight glasses and flow metering devices, check valves, and hand valves as specified herein.

1.2.1 Design Requirements

Design and fabrication of the pumps shall be in accordance with HI 7.1-7.5 and HI 9.1-9.5 except as modified herein. Pump stands and platforms shall be adequate to support the pumping system.

1.2.2 Performance Requirements

Capacity and design of the chemical feed systems and accessories shall be suitable for 24-hour full load service in ambient, non freezing conditions.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

Detail drawings containing complete piping, wiring, schematic, flow diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation.

SD-03 Product Data

Chemical Feed System

Manufacturer's descriptive and technical literature, catalog cuts, performance charts, and pump curves. List of materials, list of equipment, including a complete list of parts and supplies with current unit prices and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

Material Safety Data Sheets

Material safety data sheets, as specified.

Auxiliary Equipment and Spare Parts

List of parts recommended by the manufacturer to be replaced after 1 year of service.

SD-06 Test Reports

Field Testing

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

SD-07 Certificates

Chemical Feed System Components

One copy of certification stating that each chemical feed system component that may come in contact with the liquid being handled meets NSF/ANSI 61 standards.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment delivered and placed in storage from the weather, excessive humidity, excessive temperature variation, dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Concurrent with delivery and installation of the specified equipment, furnish auxiliary equipment and spare parts as follows:

a. Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after 1 year of service.

b. One extra of each part used that is made from glass, hard rubber, or clear plastic; one extra set of solution-hose connections; one diaphragm and three springs for each back pressure regulator; one diaphragm and air valve for each pulsation dampener; one diaphragm and three springs for each pressure relief valve; one spare strainer for each strainer.

d. One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2 CHEMICALS

Submit Material Safety Data Sheets in conformance with ANSI Z400.1 for each chemical. Chemicals shall conform to the following:

2.2.1 Disinfecting Agents

AWWA B300 hypochlorites and AWWA B302 ammonium sulfate.

2.3 CHEMICAL METERING PUMPS

2.3.1 Hypochlorite Metering Pumps

Pumps shall be solenoid-actuated type metering pumps. Each pump shall have the capacity to deliver the chemical solution at any rate ranging between the minimum and maximum specified values and shall be suitable for continuous operation within that range.

Pump repeatability shall be within plus or minus 2 percent over a range between the minimum and maximum specified values.

Pump drive and electronics shall be totally enclosed in a chemical resistant enclosure. The drive electronics, solid-state electronic pulser, shall be fully encapsulated. Termination of control and power wiring shall be made at quick-connect terminals, minimum of 3/16 inch wide, located on the drive enclosure. The pump and pump drive electric power consumption shall be 87 watts or less under full speed and full pressure conditions.

The pump shall automatically cease operation whenever discharge pressure exceeds the pump's rated pressure by 35 percent.

Specific pump specifications are as follows:

Chemical Solution: Commercial-Grade Sodium Hypochlorite (NaOCl).
Chemical Solution Concentration: Minimum 9 percent; maximum 15 percent.
Feed/Flow Rate: Minimum 0.011 gph; maximum 1.1 gph.
Back Pressure: Maximum 100 psig.
Materials of Construction for Wetted Parts:
Pump Head: Polyvinyl Chloride (PVC)/PVDF.
Check Valve Ball: Ceramic.
Diaphragm/Tube: Fluorofilm/PTFE.
Seals: PVDF/Polyprel/PTFE.

Provide for local, manual adjustment of pump stroke-length.

Provide for local and remote adjustment of pump stroke rate. Provide an LCD display to indicate pump operation. Provide tactile keypad for operator selection of pump operational mode and local adjustment of pump stroke rate. The pump shall accept an analog signal (4 to 20 mA) representative of the desired feed/flow rate for remote adjustment of pump stroke rate. Pump response (direct or reverse) to the analog signal shall be operator selectable.

Number of metering pumps: Three installed.

Metering pumps shall be as manufactured by Prominent, Model GA1a 1005, or equal.

2.3.2 Ammonium Sulfate Metering Pumps

Pumps shall be solenoid-actuated type metering pumps. Each pump shall have capacity to deliver the chemical solution at any rate ranging between the minimum and maximum specified values and shall be suitable for continuous operation within that range.

Pump repeatability shall be within plus or minus 2 percent over a range between the minimum and maximum specified values.

Pump drive and electronics shall be totally enclosed in a chemical resistant enclosure. The drive electronics, solid-state electronic pulser, shall be fully encapsulated. Termination of control and power wiring shall be made at quick-connect terminals, minimum of 3/16 inch wide, located on the drive enclosure. The pump and pump drive electric power consumption shall be 87 watts or less under full speed and full pressure conditions.

The pump shall automatically cease operation whenever discharge pressure exceeds the pump's rated pressure by 35 percent.

Specific pump specifications are as follows:

Chemical Solution: 40 percent Ammonium Sulfate ((NH4)2SO4).
Chemical Solution Concentration: Minimum 18.5 percent; maximum 19.5 percent.
Feed/Flow Rate: Minimum 0.003 gph; maximum 0.29 gph.
Back Pressure: Maximum 100 psig.
Materials of Construction for Wetted Parts:
Pump Head: PVC/PVDF.
Check Valve Ball: Ceramic.
Diaphragm/Tube: Fluorofilm/PTFE.

Seals: PVDF/Polypropel/PTFE.

Provide for local, manual adjustment of pump stroke-length.

Provide for local and remote adjustment of pump stroke rate. Provide an LCD display to indicate pump operation. Provide tactile keypad for operator selection of pump operational mode and local adjustment of pump stroke rate. The pump shall accept an analog signal (4 to 20 mA) representative of the desired feed/flow rate for remote adjustment of pump stroke rate. Pump response (direct or reverse) to the analog signal shall be operator selectable.

Number of metering pumps: Three installed.

Metering pumps shall be as manufactured by Prominent, Model GAla 1601, or equal.

2.4 CHEMICAL METERING PUMP SKIDS

2.4.1 Hypochlorite Metering Pump Skid

2.4.1.1 General Arrangement

The hypochlorite metering pump skid shall be a triplex skid. The hypochlorite metering pump skid shall be completely assembled and tested before delivery to the job site. All equipment shall be of materials selected specifically for use with sodium hypochlorite.

The required systems are schematically shown on the Mechanical and Instrumentation Drawings provided in the drawings. Deviations from these schematics are to be illustrated on these drawings and submitted for Contracting Officer review.

Provide for each hypochlorite metering pump the following:

One back pressure valve.
One pressure relief valve.
One flow through pulsation dampener.
One diaphragm protected pressure gauge.

Deliver the chemical metering feed systems assembled, complete, and tested by the manufacturer before delivery to the project site.

Configure each pump to facilitate their removal by disconnecting only the piping directly connected to their inlet and outlet piping/tubing connections and associated electrical connections. Disconnecting, removing, or modifying any adjacent piping or electrical equipment to facilitate pump removal is unacceptable.

Provide isolation valves and unions for all serviceable components.

All seals and gaskets shall be Teflon or Viton, suitable for sodium hypochlorite.

Provide the following clearances (minimum):

Between pumps: 12 inches.
Between parallel pipes: 6 inches.

All piping shall be Schedule 80 PVC as specified in Section 33 11 00 WATER DISTRIBUTION. All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

Rigidly support the pulsation dampener and calibration tube. Devices mounted unsupported directly to the piping are unacceptable.

Route electrical conduit around the ends and sides of the skid or base terminating at the terminal junction box.

Provide 3/4-inch-diameter quick-connect couplings on the pump skid suction and discharge piping for flushing and draining the pump skid piping. Provide pipe reducers as required to transition pipe diameter to 3/4-inch -diameter at the couplings if skid suction or discharge piping is a size other than 3/4-inch-diameter.

The quick-connect couplings and caps on skids with thermoplastic piping shall be polypropylene. Quick-connect couplings on the skid shall be male end couplings. Provide a padlockable female end cap with 316 stainless steel chain for each male coupling on the skid. Thermoplastic couplings shall be Evertite Part A, or equal.

The hypochlorite metering pump skid shall be manufactured by Blue Planet Environmental Systems, Inc., or equal.

2.4.1.2 Skid Design

The chemical metering skids shall be constructed from white PVC with a minimum trade thickness of 1/2 inch.

The skid shall be self-supporting with equipment and piping. Include gussets and supports in the design as needed.

All components of the chemical metering system shall be contained within the skid.

The skids shall be manufactured using continuous welding technology; bolted construction is not acceptable.

Pedestals shall be provided to elevate and mount the metering pumps above the skid base (to elevate the chemical metering above the containment structure floor).

Each pump shall be individually bolted so that it is removable independent of other pumps.

Attach the piping to the chemical metering skid with non-metallic corrosion resistant framing support system, Aikenstrut, or equal. Pipe straps shall be removable and reusable to allow for servicing of the system.

Use titanium bolts (ASTM F 468, Grade Ti1, Ti2, or Ti7), washers, and nuts (ASTM F 476) wherever metallic fasteners are required.

Clearly label all inlet/outlet connections, valves, and pump accessories on the skid.

Weld all support channels directly to the chemical metering skid. Bolted or screwed supports are not acceptable.

The skid base shall have four lifting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it.

A NEMA 4X terminal junction box (TJB) shall be provided on the skid back panel for termination of all wiring. A power outlet with weatherproof cover shall be provided for any metering pumps or accessories that require an outlet. The inside cover of the terminal box shall include a wiring diagram detailing the function of all terminals. A power disconnect switch or breaker shall be provided in the TJB. Surge protection shall be provided locally in the skid mounted TJB. Protection shall be provided for the main power supply as well as all analog input and output signals. Surge protection devices shall be as manufactured by EDCO Inc. of Florida. The NEMA 4X TJB shall provide the following I/O at a minimum:

Terminals for 120 VAC power (local heavy duty surge protection included).

15A Breaker for Main AC Power.

HOA Selector Switch for each pump.

Elapsed time meter for each pump.

DI = Remote On/Off for each pump.

AI = Remote Speed Reference for each pump (local surge protection included).

DO = Run Status for each pump.

DO = Fault Status for each pump.

2.4.1.3 Accessories

Calibration Columns:

Provide one calibration column for each hypochlorite metering pump. Size the column to provide fluid level observation for at least 30 seconds at pump's full stroke and maximum speed settings. The column shall have a minimum of 12 inches graduated in gallons and fractions thereof, to allow reading of the fluid contents. The graduation accuracy shall be 1 percent as a minimum. The column shall be clear PVC pipe, Schedule 80, conforming to ASTM D 1785 with Schedule 80 fittings. Provide the column with a cap to prevent accidental splashing of the chemical. The cap shall be suitable for installation of a ball valve for air venting.

Back Pressure and Pressure Relief Valves:

Provide separate back pressure and pressure relief valves on the discharge piping of each metering pump.

The valves' set point range shall be fully adjustable from 10 to 150 psi.

The valves' bodies shall be PVC, compatible with sodium hypochlorite.

Pulsation Dampeners:

Provide gas charged pulsation dampeners on the discharge of each pump. Size the pulsation dampeners for a minimum of 90 percent dampening.

Dampeners shall be PVC with a Viton bladder and include gas charge fitting and pressure gauge.

All materials shall be compatible with sodium hypochlorite.

Diaphragm-Protected Pressure Gauges:

Two-inch dial size liquid-filled pressure gauges with isolators shall be provided to indicate system pressure in the discharge piping of each metering pump. Industrial-quality liquid-filled Type 316 stainless steel gauges as manufactured by WIKA shall be used. The isolators shall have housings compatible with chemical as specified herein with a Teflon diaphragm and suitable liquid fill.

De-gassing Riser (DEGAS):

A de-gassing riser shall be provided in the suction header. The de-gassing riser shall be installed in front of any metering pump inlets. The de-gassing riser shall include an isolation ball valve and shall be piped in SCH-80 clear PVC to allow for visual inspection and shall terminate at the top of the metering skid. An FPT connection shall be provided for connection to rigid piping for "vent" return to the supply container.

2.4.1.4 Piping and Tubing

All piping shall be Schedule 80, PVC as specified in Section 33 11 00 WATER DISTRIBUTION.

All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.1.5 Valves

All manual valves shall be Double Union, PVC Ball Valve, with vented ball as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2 Ammonium Sulfate Metering Pump Skid

2.4.2.1 General Arrangement

The ammonium sulfate metering pump skid shall be a triplex skid. The ammonium sulfate metering pump skid shall be completely assembled and tested before delivery to the job site. All equipment shall be of materials selected specifically for use with ammonium sulfate.

The required systems are schematically shown on the Mechanical and Instrumentation Drawings provided in the drawings. Deviations from these schematics are to be illustrated on these drawings and submitted for Contracting Officer review.

Provide for each ammonium sulfate metering pump the following:

One back pressure valve.
One pressure relief valve.
One flow through pulsation dampener.

One diaphragm protected pressure gauge.

Deliver the chemical metering feed systems assembled, complete, and tested by the manufacturer before delivery to the project site.

Configure each pump to facilitate their removal by disconnecting only the piping directly connected to their inlet and outlet piping/tubing connections and associated electrical connections. Disconnecting, removing, or modifying any adjacent piping or electrical equipment to facilitate pump removal is unacceptable.

Provide isolation valves and unions for all serviceable components.

Provide the following clearances (minimum):

Between pumps: 12 inches.
Between parallel pipes: 6 inches.

All piping shall be Schedule 80 PVC as specified in Section 33 11 00 WATER DISTRIBUTION. All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

Rigidly support the pulsation dampener and calibration tube. Devices mounted unsupported directly to the piping are unacceptable.

Route electrical conduit around the ends and sides of the skid or base terminating at the terminal junction box.

The ammonium sulfate metering pump skid shall be manufactured by Blue Planet Environmental Systems, Inc., or approved equal.

2.4.2.2 Skid Design

The chemical metering skids shall be constructed from white PVC with a minimum trade thickness of 1/2 inch.

The skid shall be self-supporting with equipment and piping. Include gussets and supports in the design as needed.

All components of the chemical metering system shall be contained within the skid.

The skids shall be manufactured using continuous welding technology; bolted construction is not acceptable.

Pedestals shall be provided to elevate and mount the metering pumps above the skid base (to elevate the chemical metering above the containment structure floor).

Each pump shall be individually bolted so that it is removable independent of other pumps.

Attach the piping to the chemical metering skid with non-metallic corrosion resistant framing support system, Aikenstrut, or equal. Pipe straps shall be removable and reusable to allow for servicing of the system.

Use stainless steel washers and nuts wherever metallic fasteners are required.

Clearly label all inlet/outlet connections, valves, and pump accessories on the skid.

Weld all support channels directly to the chemical metering skid. Bolted or screwed supports are not acceptable.

The skid base shall have four fitting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it.

A NEMA 4X terminal junction box (TJB) shall be provided on the skid back panel for termination of all wiring. A power outlet with weatherproof cover shall be provided for any metering pumps or accessories that require an outlet. The inside cover of the terminal box shall include a wiring diagram detailing the function of all terminals. A power disconnect switch or breaker shall be provided in the TJB. Surge protection shall be provided locally in the skid mounted TJB. Protection shall be provided for the main power supply as well as all analog input and output signals. Surge protection devices shall be as manufactured by EDCO Inc. of Florida. The NEMA 4X TJB shall provide the following I/O at a minimum:

Terminals for 120 VAC power (local heavy duty surge protection included).

15A Breaker for Main AC Power.

HOA Selector Switch for each pump.

Elapsed time meter for each pump.

DI = Remote On/Off for each pump.

AI = Remote Speed Reference for each pump (local surge protection included).

DO = Run Status for each pump.

DO = Fault Status for each pump.

2.4.2.3 Accessories

Calibration Columns:

Provide one calibration column for each ammonium sulfate metering pump. Size the column to provide fluid level observation for at least 30 seconds at pump's full stroke and maximum speed settings. The column shall have a minimum of 12 inches graduated in gallons and fractions thereof, to allow reading of the fluid contents. The graduation accuracy shall be 1 percent as a minimum. The column shall be clear PVC pipe, Schedule 80, conforming to ASTM D 1785 with Schedule 80 fittings. Provide the column with a cap to prevent accidental splashing of the chemical. The cap shall be suitable for installation of a ball valve for air venting.

Back Pressure and Pressure Relief Valves:

Provide separate back pressure and pressure relief valves on the discharge piping of each metering pump.

The set point range of the valves shall be fully adjustable from 10 to 150 psi.

The bodies of the valves shall be PVC, compatible with ammonium sulfate.

Pulsation Dampeners:

Provide gas charge pulsation dampeners on the discharge of each pump. Size the pulsation dampeners for a minimum of 90 percent dampening.

Dampeners shall be PVC with a Viton bladder and include gas charge fitting and pressure gauge.

All materials shall be compatible with ammonium sulfate.

Diaphragm-Protected Pressure Gauges:

Provide 2-inch dial size liquid-filled pressure gauges with isolators to indicate system pressure in the discharge piping of each metering pump. Industrial-quality liquid-filled Type 316 stainless steel gauges as manufactured by WIKA shall be used. The isolators shall have housings compatible with chemical as specified herein with a Teflon diaphragm and suitable liquid fill.

2.4.2.4 Piping and Tubing

All piping shall be Schedule 80, PVC as specified in Section 33 11 00 WATER DISTRIBUTION.

All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2.5 Valves

All manual valves shall be Double Union, PVC Ball Valve, with vented ball as specified in Section 33 11 00 WATER DISTRIBUTION.

2.5 CHEMICAL STORAGE TANKS

2.5.1 Sodium Hypochlorite Storage Tanks

2.5.1.1 General

Tanks shall be rotationally-molded, vertical, high density crosslinked polyethylene with an oxidation resistant liner system, one-piece seamless construction, cylindrical in cross-section and vertical with flat bottoms. Tanks shall be adequately vented. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify that serial numbers must be permanently embossed into the tank.

The tanks shall be designed and constructed for storing sodium hypochlorite.

All components/items shall be suitable for the service application.

The nominal properties of the sodium hypochlorite tank materials shall be as follows:

Property	Type I XLPE	ASTM Test
Environmental Stress Cracking Resistance, F50, hours, 10 percent Igepal	>1,000	ASTM D 1693
Tensile Strength, Ultimate psi, 2-inch /minimum	2,830	ASTM D 638 Type IV Specimen
Elongation at Break, percent, 2-inch minimum	700	ASTM D 638 Type IV Specimen
Flexural Modulus, psi	86,780	ASTM D 790

The tanks shall be molded from HDXLPE. The resin used shall be Paxon 7004 as manufactured by Exxon/Mobil Chemical. Interior of each tank shall have an oxidation resistant liner.

The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent and maximum of 0.60 percent U.V. stabilizer. Pigments added shall not exceed 0.5 percent of the total weight of the tank if dry blended or 2 percent if melted compound. Tank color shall be natural and have molded-in gallonage markers on the tank wall.

The tanks shall be permanently marked to identify the serial number. Tanks shall be labeled as recommended by the Manufacturing Chemists Association.

The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus 3 percent. Measurement shall be taken in a horizontal position.

On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. In most cases, flat areas shall be provided for attachment of large fittings on the dome of the tank.

The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be:

Tank Diameter, feet	Min. Knuckle Radius, inch
Less than or equal to 6	1
Greater than 6	1-1/2

The minimum wall thickness shall be 1/4 inch in all places. All edges cut shall be trimmed smooth. Use flexible connections at all lower sidewall fittings.

2.5.1.2 Tank Fittings

All tank fittings specified herein shall be furnished by the tank manufacturer. These tank fittings are not necessarily shown in the drawings. The Contractor shall coordinate the location of the following accessories with the drawings before submitting shop drawings for the tank:

Provide one PVC U-vent per tank located at the peak of the tank dome. Provide a non-metallic insect screen compatible with the sodium hypochlorite on each tank vent. Vents shall be sized by the tank manufacturer. Vents shall comply with OSHA standards.

Provide one Schedule 80 PVC fill dip/drop pipe per tank. Each dip/drop pipe shall discharge 6 inches above tank floor and fitted with a wear plate or baffle assembly to prevent erosion of tank surface. Each dip/drop pipe shall be furnished with a non-obtrusive (no tank, wall penetrations) pipe support system.

Pipes shall be supported at 4-foot maximum intervals.

Flexible Couplings/Connections: Provide Viton/PTPE flexible coupling/connection assemblies for connection of piping to the lower sidewall fitting of the tanks in accordance with the tank manufacturer's requirements and recommendations. Flange bolting shall be titanium.

2.5.1.3 Tank Accessories

Provide complete restraint system, including cables, turnbuckles, thimbles, clips, epoxy adhesive type anchor bolts by the Contractor, and all other necessary hardware to secure tank to concrete support pad. All items shall be 300-series stainless steel construction.

Restraint system shall be designed to meet 130 mph (minimum) wind load condition.

2.5.1.4 Sodium Hypochlorite Tank Manufacturer

Number of Tanks: Two.
Minimum Tank Capacity: 155 gallons.

The storage tanks shall be manufactured by Poly Processing Inc., or approved equal.

2.5.2 Ammonium Sulfate Storage Tanks

The ammonium sulfate solution shall be supplied by the manufacturer in 55-gallon drums.

2.6 INJECTORS

2.6.1 Sodium Hypochlorite Injectors

Sodium hypochlorite solution injectors shall be removable Hastelloy (Alloy C-276) chemical injection assemblies.

Solution tube tip shall enter into the main pipe to a minimum of one-third and a maximum of half the pipe diameter and have a 45-degree angle cut facing downstream inside the pipe main. Diffusers shall be removable/insertion type that can be removed without shutting down the main process piping. Include a locking device to prevent accidental release of the solution tube from the pressurized main. Include a stainless steel safety chain to prevent withdrawal of the solution tube past the corporation stop. Include a ball check valve to prevent backpressure from the main from entering the chemical feed system. Provide a flexible hose assembly to connect from the containment piping to the injector.

The manufacturer shall furnish and install one complete sodium hypochlorite injection assembly (injector, flexible hose, and isolation valve) at each sodium hypochlorite application location indicated in the drawings.

The manufacturer shall furnish and install one corporation stop valve with plug at each unused tap.

The manufacturer shall furnish one complete spare injector to the Contracting Officer.

Injectors with flexible hosing shall be EB-120 Series by Saf-T-Flo Industries Corporation, Anaheim, CA, or approved equal.

2.6.2 Ammonium Sulfate Injectors

Ammonium sulfate solution injectors shall be removable Hastelloy (Alloy C-276) chemical injection assemblies.

Solution tube tip shall enter into the main pipe to a minimum of one-third and a maximum of one-half the pipe diameter, and have a 45-degree angle cut facing downstream inside the pipe main. Diffusers shall be removable/insertion type that can be removed without shutting down the main process piping. Include a locking device to prevent accidental release of the solution tube from the pressurized main. Include a stainless steel safety chain to prevent withdrawal of the solution tube past the corporation stop. Include a ball check valve to prevent backpressure from the main from entering the chemical feed system. Provide a flexible hose assembly to connect from the containment piping to the injector.

The manufacturer shall furnish and install one complete injection assembly (injector, flexible hose, and isolation valve) at each ammonium sulfate application location indicated in the drawings.

The manufacturer shall furnish and install one corporation stop valve with plug at each unused tap at the ammonium sulfate application location.

The manufacturer shall furnish one complete spare injector to the Contracting Officer.

Injectors with flexible hosing shall be EB-120 Series by Saf-T-Flo Industries Corporation, Anaheim, CA, or approved equal.

2.7 SODIUM HYPOCHLORITE BAG FILTERS

Sodium hypochlorite bag filter body, bag hold-down unit, and restrainer basket shall be constructed of PVC. Cover shall be PVC with Viton O-ring. Provide the double length bag size filter housing capable of chemical flow rates of 100 gpm with clean filter bags. Inlet, outlet, and drain piping connections shall be 2-inch-diameter true union connections. Provide two 100-micron polypropylene double length filter bags for each filter unit with one serving as a spare. Filter bags shall be Hayward DURAGAF P02E, or approved equal. Bag filters shall be Hayward Filtration System Polyline Simplex Bag Filter Housing with Double Length Bag Size. Adapters shall be Evertite Part A/DC, Banjo Corporation Male Adapter/Female Thread and Cap, Murray Equipment Inc. Style A/DC, or approved equal.

PART 3 EXECUTION

3.1 FACTORY TESTING OF METERING PUMP SKIDS

The metering pump skid manufacturer shall do the following regarding factory testing for each skid:

Test the packaged chemical feed system in the factory and provide factory testing certificates to the Engineer. Factory tests are subject to be repeated at no additional cost to the Government until the Government or Contracting Officer are satisfied that the equipment is operating correctly.

Pressure test skid piping (except for overflow and vent piping) using water to a pressure of 150 psi for 3 hours. During this 3-hour test there shall no leakage at any pipe joint or connection to any valve or piece of equipment. Repair or replace any defective pipe joint or connection and retest.

Test each package system by using water and temporary storage tanks and interconnecting piping. Operate the control system by simulating the external control signals. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signal. Verify that the metering pumps stage on and off in response to the control signal.

After successfully demonstrating that the systems function properly using water, drain and remove the water from the chemical systems. Nitrogen gas shall be used to completely dry out the piping before storing or shipping.

3.2 INSTALLATION

3.2.1 Chemical Feed Equipment

Install metering pump skids, metering pumps, and appurtenance in accordance with the manufacturer's instructions.

3.2.2 Pipe, Tubing, Hangers and Supports

The installation of pipes and tubes shall be in accordance with Section 33 11 00 WATER DISTRIBUTION.

3.3 FIELD PAINTING

Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top-coated with the manufacturer's standard factory finish provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00.00 98 PAINTS AND COATINGS. Coating shall be not less than 1.75 mils thick. Piping identification shall be as specified in Section 09 90 00.00 98 PAINTS AND COATINGS. Pipe carrying materials not listed in Section 09 90 00.00 98 PAINTS AND COATINGS shall be marked in accordance with ASME A13.1.

3.4 FIELD TESTING

Conduct operating test on each metering pump, after installation is complete, as specified herein. Prepare and submit reports of these tests for review and comment prior to final acceptance of the installation. The required test shall be as follows:

Metering Pump Performance

Record the pump delivery flow rate at the specified back pressure as follows:

50-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

100-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

10-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

Zero percent of pump stroke rate; 10, 50, and 100-percent of maximum pump stroke length.

Plot the recorded pump performance on manufacturer's characteristic performance curves.

Note vibration of pump during testing.

Neutralize all chemicals wasted during testing to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/l). Dispose of wasted chemicals in a matter acceptable to the Contracting Officer. For bidding purposes, assume chemicals will be wasted to an onsite tank. Coordinate with the Contracting Officer regarding quantity of waste anticipated.

3.5 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 FIELD TRAINING

Conduct a field training course for designated operating, maintenance and supervisory staff members. Training shall be provided for a total period of 2 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the Operating and Maintenance Instructions.

-- End of Section --

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POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.1 SCOPE OF WORK

Furnish all labor, materials, and incidentals required to provide positive displacement (PD) blower equipments specified in this Section and shown on the Drawings. The blowers shall be rotary, positive displacement, belt-driven, and shall be complete with all appurtenances necessary to make the equipment complete and operable in compliance with the following Specifications.

1.2 RELATED WORK

Section 01 33 00, SUBMITTAL PROCEDURES
Section 01 78 00, CLOSEOUT SUBMITTALS
Section 01 78 23, OPERATION AND MAINTENANCE DATA
Section 09 90 00.00 98, PAINTING AND COATING
Section 33 71 02.00 20, UNDERGROUND ELECTRICAL DISTRIBUTION
Section 40 95 00, PROCESS CONTROL SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Specs	Bearing Life Specifications

ASME INTERNATIONAL (ASME)

ASME PTC 9	(1970; R 1997) Displacement Compressors, Vacuum Pumps and Blowers (for historical reference only)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG1	(2010; Rev 1) Motors and Generators

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Shop drawings shall be in accordance with the paragraph entitled "DRAWINGS."

SD-03 Product Data

Motor Information; G

Complete motor nameplate data as defined by NEMA, the manufacturer, and any motor modifications. For energy-efficient motors, provide a certified copy of the test report for a similar motor tested in accordance with NEMA MG1-12.54 and IEEE 112, Test Method B, showing full-load efficiency meeting or exceeding specified values. Motors not as specified will be rejected.

1/2, 3/4, and full-load efficiencies and power factors.

Blower; G

The manufacturer shall supply an engineered blower selection showing the expected noise level of the blower without the enclosure and the attenuation rating for the enclosure in dBA.

Product Data shall including the manufacturer's descriptive literature.

SD-05 Design Data

Data Curves; G

Discharge Temperature; G

L10 Bearing Life Calculations; G

Silencers; G

Pressure Relief Valves; G

v-belt

Coupling Drive calculations; G

Exceptions; G

Provide all data in accordance with the paragraph entitled "DESIGN DATA."

SD-07 Certificates

Manufacturer's Certification; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA; G

1.5 DRAWINGS

Shop drawings shall show assembled packaging stating what items will be shipped to the job site assembled and those shipped loose for field assembly.

1.6 DESIGN DATA

Data submitted shall include the following information:

Data Curves: Performance data curves showing pressure, capability, horsepower demand, and speed over the entire operating range of the unit(s).

Discharge Temperature at ambient temperature and normal system operating conditions.

L10 Bearing Life Calculations for each bearing.

Silencers: An attenuation performance curve for each type of silencer.

Pressure Relief Valves: set pressure.

Coupling Drive calculations.

A list of all exceptions and an explanation of each non-compliance with the specifications. If it is impossible to conform to certain details of this Section due to different manufacturing techniques, describe completely all non-conforming aspects.

1.7 QUALITY ASSURANCE

All air blowers and appurtenances furnished under this Section shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best industry practices and methods.

Routine tests shall be performed on representative motors and shall include the information described on NEMA MG1-12.54 Report of Test Form for Routine Tests on Induction Motors. Efficiency shall be determined in accordance with IEEE 112, Method B.

Should equipment which differs from this Section be offered and determined to be the equal of that specified, such equipment will be acceptable only on the basis that any revisions in the design and/or construction of the structures, piping, appurtenant equipment, etc required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Contracting Officer.

Equipment furnished under this Section may be supplied through a system packager other than the blower manufacturer only if the following conditions are complied with:

1. The blower manufacturer shall supply in writing that they have

reviewed the intended application and that the complete prepared package and all components are satisfactorily sized and arranged for the intended use and location

2. The blower manufacturer shall supply warranties on the blowers in compliance with Section 01 78 00, CLOSEOUT SUBMITTALS. Such warranties shall be in addition to warranties supplied by the system packager and shall be all-inclusive with regard to the blower equipment, including acknowledgement that the warranty applies to the units as packaged by others.

The blower system manufacturer shall be an authorized warranty service center for the bare blower provided.

Blower system suppliers must submit an authorization letter from the bare blower manufacturer of the blower proposed to be installed, to the Contracting Officer at least 10 working days before the bid opening for the system to qualify for use on the project. The letter shall state the system manufacturer is qualified to design and build blower systems for the application and is authorized to perform warranty work.

Blowers, motors, and all primary components shall be manufactured in the United States with replacements and parts available from multiple sources within the United States.

1.8 DELIVERY, STORAGE, AND HANDLING

Care must be taken during unloading and handling of equipment to ensure against undue strain to the blower and motor. Do not use lifting straps or chains under the blower or motor. Lift from under the main frame or base or use base-mounted lifting lugs (if provided).

In storage blowers must be kept clean, free of moisture, and rotated a minimum of twenty revolutions each week to maintain warranty. For storage in excess of 4 months or in a damp or corrosive environment, see the manufacturer's operation and maintenance manual.

1.9 WARRANTY

Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Section 01 78 00 CLOSEOUT SUBMITTALS.

1.10 OPERATION AND MAINTENANCE MANUALS

Operations and Maintenance Manuals shall be in accordance with General Conditions, Supplementary Conditions, and Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.11 DEFINITIONS

SCFM. Standard cubic feet per minute is understood to be air at 68 degrees F, 14.7 pounds per square inch gauge (psig), and 36 percent relative humidity flowing at a rate of 1 cubic foot per minute.

ICFM. The volume of air in cubic feet per minute actually entering the blower inlet at the atmospheric condition specified.

Discharge Pressure. The pressure in psig measured at the blower discharge flange.

Overall Efficiency. The total efficiency for the motor, drive, and blower from the motor terminals to the pumped air.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

Each of the four PD blowers shall be designed for the following conditions of service: each PD blower shall be capable of delivering the volume of air when operating at an elevation of 0 feet above sea level and inlet temperatures varying from 30 degrees F to 100 degrees F. The equipment manufacturer shall indicate 100 degrees F and 85 percent relative humidity ambient air summer condition; overall efficiency at the guarantee point. Blower enclosures shall be suitable for outdoor installation.

Process performance requirements:

1. PD Blower No. 1, 2, 3, and 4:

Site Elevation, FASL	0
Maximum Inlet Temperature, degrees F	100
Maximum Relative Humidity, percent	85
ICFM plus/minus 4 percent	137
Differential Pressure, psig	8.0
Maximum blower brake horse power required	7.8
RPM limit at above SCFM	1765
Motor Size, hp	15
Sound Limit Required: (at 3.28 feet in free field)	78
Installation Location	Outside as shown on the drawings
Hp	Nameplate greater than the brake horsepower at 10 percent above the relief valve set pressure
RPMs	1800
Type	TEFC
Power	460-volt, 3-phase, 60-Hertz
Insulation	Class F with Class B rise
Service Factor	1.15 at power voltage and site elevation listed above

Efficiency	"Premium efficient" in accordance with latest edition of NEMA MG1

2.2 ACCEPTABLE MANUFACTURER

The blower assembly package, including frame and base, shall be as manufactured by:

a. Universal Blower Pac, Inc. with Sutorbilt Model 4MQ.
b. Approved equal.

All PD blowers shall be provided by the same manufacturer.

2.3 EQUIPMENT

2.3.1 Blower Assembly Frame and Base

A common base and frame shall be supplied with each blower assembly with provisions on which to mount the blower, drive, motor, and intake silencer with filter, discharge silencer, and sound limiting enclosure. Each base shall be welded fabricated-steel construction, suitably reinforced. Bare base weight shall be greater than or equal to 50 percent of blower weight and not less than 100 pounds.

Each motor mounting base shall include all necessary provisions to permit proper blower/motor alignment. For V-belt drive unit(s), motor mounting bases shall be the adjustable two-rail type, each rail having a corresponding threaded rod to facilitate alignment and drive belt replacement/tensioning.

2.3.2 Blower

The blower shall be the two-lobe, two-impeller, belt-driven, rotary positive-displacement type, with top inlet and bottom outlet. The blower shall be frame mounted with intake silencer, blower, motor, and discharge silencer. Blower output shall be regulated by motor speed, which is controlled by interchangeable motor and blower sheaves and corresponding drive belts.

Each blower casing shall be of one-piece construction with separate headplates. Casings and head plates shall be made of close-grained cast iron suitably ribbed to prevent distortion under the specified operating conditions. Inlet and outlet connections shall be threaded and shall be an integral part of the blower casing.

The impellers shall be the straight, two-lobe type and shall operate without rubbing or liquid seals or lubrication. Impellers shall be constructed of ductile iron or close-grained cast iron, suitably ribbed internally. All impellers shall be statically and dynamically balanced and machined on all exterior surfaces for operating at close tolerances. The impellers shall be attached to forged, machined alloy-steel shafts by flanges, or shafts may be an integral part of the impeller. Shafts shall be of one-piece straight-through design or two-piece design designed to withstand all operating loads imposed.

The impellers shall be positively timed by a matched pair of timing gears. Timing gears shall be designed and manufactured for continuous service in accordance with AGMA Standards. Timing gears shall be fully machined from alloy steel, bolted to timing hubs, and adjustable for field retiming. Timing hubs shall be splined to the shaft and locked in place by a suitable lock nut.

Each impeller and shaft assembly shall be supported at each end by double-row spherical bearings. All bearings shall have a rating life of 100,000 hours as defined by AFBMA Specs.

Lubrication to the timing gears and gear-end bearings of each blower shall be maintained by an oil bath relying on gears to splash lubricate all moving parts. The oil system shall have sufficient capacity and cooling provisions to provide adequate oil to the gears and bearings with a continuous service interval between oil changes of not less than 2,000 hours. High-temperature Viton oil seals shall be provided to prevent lubricant from leaking into the air stream or into the atmosphere. The drive end bearings shall be grease lubricated through exterior grease fittings.

Sight glasses shall be provided for oil level observation. Each sight glass shall be able to indicate that a safe oil level exists during blower operation and accurately indicate the amount of oil present when the blower is off.

2.4 ACCESSORIES

2.4.1 Lifting Lugs

Where practical or applicable, individual equipment and/or each component part over 100 pounds shall be provided with lifting lugs for easy handling.

2.4.2 Intake Filter

Each blower shall be furnished with a dry-type element inlet filter. The filter medium shall be paper filter media capable of filtering 2-micron solids with a 99.5 percent solids-retention efficiency with a pressure drop of less than 2 inches of water column.

2.4.3 Inlet Silencers

The inlet silencer shall be heavy-duty, welded-steel construction, two-chamber absorptive type. The silencers shall provide attenuation suitable for critical pitch line velocity applications.

Pressure drop through the inlet silencer shall be minimal.

The inlet silencers shall be capable of handling the process performance requirements specified in the paragraph entitled "Performance and Design Requirements" of this Section.

Silencer shall be:

a. Progentex, Inc., Series DS, RSI, DRSI.
b. Universal Silencer, Inc., Series U5, URB, RIS.
c. Burgess Manning Series CA, BMAI, BMSI.
d. Stoddard series L/C21, D13/41, D61/23.
e. Or approved equal.

Combination type inlet filter/silencers shall not be permitted.

2.4.4 Discharge Silencers

The discharge silencers shall be heavy-duty, welded-steel construction, two-chamber absorptive type. The silencers shall provide attenuation suitable for critical pitch line velocity applications.

The blower discharge silencers shall be capable of handling the conditions specified in the paragraph entitled "Performance and Design Requirements" of this Section.

Silencer shall be:

a. Progentex, Inc., Series DS, RS, DRS.
b. Universal Silencer, Inc., Series U5, URB, SD.
c. Burgess Manning Series CA, BMA, BMSS.
d. Stoddard Series L/C21, D13, D32/33.
e. Or approved equal.

Combination type discharge silencer/base frames shall not be permitted.

2.4.5 Pressure Relief Valves

The Contractor shall provide a spring or weighted discharge pressure-relief valve installed on the discharge silencer. This valve is to be set to relieve at 1 psig above the blower maximum operating pressure and shall be factory set and tested during the shop performance test. If the valve malfunctions, it shall do so in the open position to prevent blower damage.

2.4.6 Check Valve

Provide wafer, cast-iron body, disc-type check valve for mounting on blower discharge piping. Furnish a valve with 304 SS internals, 304 SS spring, and Teflon seat material.

2.4.7 Vibration Isolator Pads

Provide molded, synthetic rubber and cork, vibration-isolation pads for each blower. Vibration-isolation pads shall be sized to fit the structural steel base.

2.4.8 Discharge Pressure Gauge

The Contractor shall furnish and field-install a glycerine-filled pressure gauge at each blower discharge.

a. Range: 0-15 psi.

b. Accuracy: 2 percent of full scale, maximum.

c. Dial: 2-1/2-inch-diameter 270 degree scale; heavy-gauge aluminum with white background and black markings; 0.25-psig minor divisions.

d. Case: Stainless steel.

e. Ring: Stainless steel.

f. Movement: Stainless steel.

g. Bourdon Tube: Phosphor bronze, large bore tubing which is silver soldered to socket and tip.

h. Connection: Forged brass 1/4-inch NPT black connection.

i. Gauges shall be WIKA Model 233.53, Ashcroft Type 1009, or approved equal.

2.4.9 Lubrication and Special Operating Supplies

Lubrication oil shall be the manufacturer's approved synthetic high-temperature-duty type (e.g., Mobil 1) as manufactured by Mobil Oil Company or approved equal.

2.5 MOTORS AND DRIVERS

2.5.1 Motors

The blowers motors shall be rated for 7.8 hp with a nominal motor speed of 1800 rpm. Motors shall operate on 460-volt, 60-Hertz, three-phase power. Motors shall be of the TEFC type with 1.15 service factor. The motor shall be premium efficiency.

The horsepower rating of all motors shall accommodate all brake horsepower conditions of blower performance without exceeding the temperature rating of the motor windings.

2.5.2 Belt Drive

Each blower shall be driven by a constant-speed v-belt drive assembly, equipped with integral electric drive motor and motor support. The drive assembly shall employ a belt transmission consisting of two pulleys connected by a V-belt. The output speed of the drive shall be capable of being changed by replacement of the pulleys. All rotating surfaces shall be enclosed by a removable guard. The drive assembly shall have a service factor of 1.14.

PART 3 EXECUTION

3.1 INSTALLATION

Blowers are recommended to be installed on a non-moving foundation with the industry standard depth of twice the blower gear diameter or a pad two times the total mass of all rotating compartments, whichever depth is greater.

If these recommendations cannot be accommodated, the following points must be followed to ensure an adequate installation:

1. The blower pad must be located on the equivalent of compacted soil substructure, which will allow the pad to remain flat, rigid, and free of resonant frequencies within the operating range of the equipment.

2. The blower must be anchored using bolts intended specifically for dynamic loading.

3. The area between the base and pad must be filled with 1 inch minimum of non-shrink grout.

4. The unit must be installed and leveled in accordance with the

manufacturer's installation instructions supplied in the O&M manual.

Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.2 PAINTING AND SURFACE PREPARATION

Factory surface preparation and painting shall be the manufacturer's standard.

3.3 SHOP TESTING

Each blower shall be statically and dynamically balance tested at the factory. Each blower shall receive a certified slip test in accordance with ASME PTC 9. A test report confirming capacity shall be furnished complete with data and calculations. The test consists of blanking off discharge and measuring the speed of the blower to maintain discharge pressure of 1 psig. Also recorded shall be inlet temperature, barometer, and discharge gauge pressure. Slip RPM recorded shall be corrected by formula in ASME PTC 9 to specified performance requirements.

Each blower shall be given a factory mechanical test to ensure mechanical integrity. If the test indicates that adjustments are necessary to ensure conformance with specifications, such adjustments shall be made before shipment.

3.4 FIELD TESTING

The Contractor shall provide services of a factory-authorized service representative to perform, approve, and certify the pre-startup testing and startup testing specified in this Section. The service representative shall be certified and employed by the manufacturer of the equipment specified in this Section.

1. The factory-authorized service representative shall be onsite to perform the testing services specified in this Section for one 8-hour day, excluding travel time.

2. Pre-Startup Testing:

a. Visually inspect the blowers and certify that the motor has been furnished in accordance with the Specifications in this Section as to horsepower, maximum input torque (100 percent rated load), voltage, phase, and hertz.

b. Visually inspect and verify that the incoming electrical service and controls have been installed in accordance with the manufacturer's recommendations.

c. Verify that the blower control panel has been furnished with all of the controls and alarms specified in this Section and has been installed in accordance with the manufacturer's recommendations.

d. Verify that the units have been properly installed and are in proper alignment.

e. Verify that there are no mechanical defects in any of the parts.

3. Startup Testing:

a. The factory-authorized service representative shall perform the startup testing specified in this Section in accordance with this Section.

b. With the lift station filled to the maximum water surface elevation shown on the Contract Documents, verify:

(1) That the units operate without overheating or overloading of any parts and without objectionable vibration.

(2) That the blowers can deliver the specified pressures and air flow rates.

(3) That the controls meet the performance requirements stated in this Section.

(4) That the alarms and safety shutdowns have been installed in accordance with the Contract Documents and the manufacturer's recommendations. These features shall be checked by artificially simulating an alarm and/or safety shutdown or control condition.

4. Final acceptance depends on the satisfactory operation and performance after installation.

3.5 TRAINING SERVICES

The factory-authorized service representative shall be onsite to perform training services for one 8-hour day, excluding travel time.

3.6 MANUFACTURER'S CERTIFICATION OF COMPLIANCE

The Contractor shall furnish a Manufacturer's Certification of Compliance for the equipment specified in this Section.

The equipment manufacturer shall provide a written report covering findings and installation approval. The report shall describe all inspections and any deficiencies noted and shall be mailed directly to the Contracting Officer.

3.7 MAINTENANCE

3.7.1 Spare Parts

The Contractor shall furnish the following spare parts in clearly identified containers, labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

a. One set of drive belts for each blower supplied.

b. One interchangeable set of sheaves for each PD Blower.

c. One filter element for each inlet filter/silencer supplied.

d. One-year supply of each lubricant required. Lubricants shall include alternate references to equal products of other manufacturers, including specifications such as AGMA numbers, viscosity, etc.

e. Additional spare parts shall be provided in accordance with the recommendations of equipment manufacturers.

-- End of Section --